Field Management of Chemical and Biological Casualties Handbook

Fifth Edition

2016

Borden Institute
US Army Medical Department Center and School
Health Readiness Center of Excellence
Fort Sam Houston, Texas

US Army Medical Research Institute of Chemical Defense
Aberdeen Proving Ground, Maryland

Office of The Surgeon General
United States Army
Falls Church, Virginia

Borden Institute
John H. Garr, MD, MSE, FACEP
Colonel, MC, US Army
Director and Editor in Chief

Disclaimer: The purpose of this handbook is to provide concise, supplemental reading material for attendees of the Field Management of Chemical Casualties Course. Every effort has been made to make the information contained in this handbook consistent with official policy and doctrine.

This handbook, however, is not an official Department of the Army publication, nor is it official doctrine. It should not be construed as such unless it is supported by other documents.

Dosage Selection: The authors and publisher have made every effort to ensure the accuracy of dosages cited herein. However, it is the responsibility of every practitioner to consult appropriate information sources to ascertain correct dosages for each clinical situation, especially for new or unfamiliar drugs and procedures. The authors, editors, publisher, and the Department of Defense cannot be held responsible for any errors found in this book.

Use of Trade or Brand Names: Use of trade or brand names in this publication is for illustrative purposes only and does not imply endorsement by the Department of Defense.

Neutral Language: Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

The opinions or assertions contained herein are the personal views of the authors and are not to be construed as doctrine of the Department of the Army or the Department of Defense. For comments or suggestions on additional contents in forthcoming editions, please contact the publisher (www.cs.amedd.army.mil/borden).

CERTAIN PARTS OF THIS PUBLICATION PERTAIN TO COPYRIGHT RESTRICTIONS. ALL RIGHTS RESERVED.

NO COPYRIGHTED PARTS OF THIS PUBLICATION MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL (INCLUDING PHOTOCOPY, RECORDING, OR ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM), WITHOUT PERMISSION IN WRITING FROM THE PUBLISHER OR COPYRIGHT OWNER.

Published by the Office of The Surgeon General
Borden Institute
Fort Sam Houston, Texas
2016

Library of Congress Cataloging-in-Publication Data

Names: Hurst, Gary (C. Gary), editor. | Borden Institute (U.S.), issuing body. | U.S. Army Medical Research Institute of Chemical Defense, issuing body.
Title: Field management of chemical and biological casualties handbook / editors, Colonel (Ret) Gary Hurst [and seven others].
Description: Fifth edition. | Fort Sam Houston, Texas : Borden Institute, 2016. | Includes index. | "Borden Institute, US Army Medical Department Center and School, Health Readiness Center of Excellence, Fort Sam Houston, Texas ; US Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, Maryland ; Office of The Surgeon General, United States Army, Falls Church, Virginia." | Preceded by Chemical Casualty Care Division's field management of chemical casualties handbook / editors, Gary Hurst ... [et al.]. Fourth edition. 2014.
Identifiers: LCCN 2016029117
Subjects: | MESH: Chemical Warfare Agents | Biological Warfare Agents | Decontamination--methods | Military Medicine--methods | United States | Handbooks
Classification: LCC RA1219.5 | NLM QW 39 | DDC 615.9--dc23 LC record available at Caution-https://lccn.loc.gov/2016029117

Printed in the United States of America
21, 20, 19, 18, 17, 16 5 4 3 2 1

Contents

Introduction ix

1. Nerve Agents 1

2. Vesicants 19

3. Cyanide 29

4. Lung-Damaging Agents and Toxic Industrial Chemicals 33

5. Riot-Control Agents 43

6. Incapacitating Agents 49

7. Biological Agents 53

8. Toxins 67

9. Field Management and Triage of Contaminated Casualties on the Integrated Battlefield 71

10. Patient Decontamination Station: Planning, Setup, and Operation 81

11. Individual Protective Equipment 131

12. Military Working Dogs in Contaminated Environments 149

Appendices 175

Index 197

Nerve Agents

Vesicants

Cyanide

Lung-Damaging Agents and Toxic Industrial Chemicals

Riot-Control Agents

Incapacitating Agents

Biological Agents

Toxins

Field Management and Triage of Contaminated Casualties on the Integrated Battlefield

Patient Decontamination Station: Planning, Setup, and Operation

Individual Protective Equipment

Military Working Dogs in Contaminated Environments

Appendices

US Army Medical Research Institute of Chemical Defense

Editors

Colonel (Ret) Gary Hurst, Medical Corps, US Army
Lieutenant Colonel (Ret) John Stich, AN, US Army
Colonel Martha K. Lenhart, Medical Corps, US Army
Lieutenant Colonel (Ret) Tim Byrne, Biomedical Science Corps, US Air Force
Major Devin Wiles, Medical Corps, US Army
Staff Sergeant Gary Hall, US Army
Daniel Boehm
Laukton Rimpel

Acknowledgments

Colonel James Madsen, Medical Corps, US Army
Major Kelley Evans, Veterinary Corps, US Army
Laura Boehm
Peter Hurst
Diana Phillips

Introduction

A turning point in world history began near the end of the 20th century as the Soviet Union fell and new anti-Western threats emerged, challenges that will persist well into the coming century. The ability and will to wage war on a large scale has not diminished, only shifted to new players. Strident nationalism, religious extremism, and long-suppressed ethnic rivalries have emerged, resulting in vicious warfare. Economic investment and economic power have given military muscle to nations that, even 10 years ago, were struggling just to feed their people. As a consequence of these unprecedented world challenges, the threat faced by the United States has broadened. It now includes formerly democratic governments, members of regional cooperative alliances, and terrorist groups. Throughout the world, nations and terrorists are attempting to produce, or have already produced, agents of chemical and biological warfare and the means to employ them.

This publication provides information relative to specific US Army tactics, techniques, procedures, and tasks associated with health service support. It is written from the point of view of a conventional forward-deployed, ground-based medical element performing patient operational decontamination and thorough patient decontamination operations while providing medical treatment at Roles 1 through 3. This handbook will serve as a guide for the mission of providing health service support to chemical and biological casualties.

Chapter 1

NERVE AGENTS

Summary

NATO Codes: GA, GB, GD, GF, VX

Signs and Symptoms:

Vapor, small dose: miosis, rhinorrhea, mild difficulty breathing.

Vapor, large dose: sudden loss of consciousness, convulsions, apnea, flaccid paralysis, copious secretions, miosis.

Liquid on skin, small to moderate dose: localized sweating, nausea, vomiting, feeling of weakness.

Liquid on skin, large dose: sudden loss of consciousness, convulsions, apnea, flaccid paralysis, copious secretions.

***Field Detection*:** Joint Chemical Agent Detector (JCAD), M256A1 Chemical Agent Detector Kit, M18A2 Chemical Agent Detector Kit, M8 Chemical Agent Detector Paper, M9 Chemical Agent Detector Paper, Improved Chemical Agent Monitor (ICAM), M93 series Fox Reconnaissance System, M21 Remote Sensing Chemical Agent Alarm (RSCAAL), M90 Chemical Warfare Agent Detector, M22 Automatic Chemical Agent Detection Alarm (ACADA).

Decontamination: Reactive Skin Decontamination Lotion, soap and water, 0.5% hypochlorite solution.

Management: Administer three Antidote Treatment Nerve Agent Autoinjectors (ATNAAs) and one Convulsive Antidote, Nerve Agent (CANA) to severe casualties; support airway for respiratory distress.

Overview

Nerve agents are the primary chemical warfare agent threat because of their high toxicity and effectiveness through multiple routes of entry. They are absorbed through the eyes, respiratory tract, and skin.

Toxicity

The classic nerve agents are tabun (GA), sarin (GB), soman (GD), GF, and VX. Tables 1-1 and 1-2 show the toxicities of the nerve agents by inhalation and skin exposure.

The Ct product, or C (concentration) × t (time), is a marker of the vapor or aerosol dose to which someone has been exposed. The agent's weight is used for C and period of exposure in minutes for t. A person exposed to a high concentration for a short time may have the same dose as someone exposed to a low concentration for a longer time.

The LCt_{50} is the Ct of agent vapor that will be lethal (L) to half of the population exposed to it. The ICt_{50} is the Ct that will incapacitate (I) half of those exposed to it. Table 1-1 shows the estimated LCt_{50}, ICt_{50}, and Ct that will cause pinpoint pupils (miosis) in half of the exposed population (MCt_{50}).

Table 1-1. Comparative Nerve Agent Vapor Toxicity*

Agent	LCt_{50}	ICt_{50}	MCt_{50}
GA	400	300	2–3
GB	100	75	3
GD	70	Unknown	< 1
GF	Unknown	Unknown	< 1
VX	50	35	0.04

*For this table, one concentration of VX = 50, and one concentration of GB = 100, meaning it would take 2 times more GB to have the same median lethal dose as one concentration of VX.
LCt_{50}: median lethal concentration/time
ICt_{50}: median incapacitation concentration/time
MCt_{50}: median first noticeable effect (of miosis) concentration/time

Table 1-2. Comparative Median Lethal Dose Values on Skin*

Agent	Amount
GA	100
GB	170
GD	5
GF	3
VX	1

*Refer to FM 3-11.9, *Potential Military Chemical/Biological Agents and Compounds*, for specific LD_{50} information. For this table, one dose of VX = 1, and 170 doses of GB = 170, meaning it would take 170 times more GB to have the same median lethal dose as one dose of VX.

The LD_{50} is the dose (D) of agent liquid or solid that is lethal (L) to half of the population exposed to it. The LD_{50} of VX is the size of a droplet as wide as two columns of the Lincoln Memorial on a Lincoln penny. Table 1-2 compares median lethal values of nerve agents when placed on the skin.

Mechanism of Action

Nerve agent poisons block the action of the enzyme acetylcholinesterase (AChE). The normal function of acetylcholinesterase is to break down (hydrolyze) the chemical messenger, or neurotransmitter, acetylcholine (ACh).

The nervous system is made up of electrically conducting cells called neurons (nerve cells). Neurons convey information by electrical signals, called action potentials. When an electrical signal reaches the end of the neuron, the information must be conveyed to the next cell by means of a chemical messenger, or neurotransmitter. Cholinergic neurons use ACh as the neurotransmitter to communicate with other cells. When an electrical signal reaches the end of a cholinergic neuron, the neuron releases packets of ACh. These cross a space, called a synaptic cleft, to the next cell in the series, another neuron, gland cell, or muscle cell. There they interact with specialized proteins called synaptic receptors. The interaction of enough molecules of

ACh with postsynaptic receptors, or receptors on the second cell, causes a new electrical signal that conveys the communication into the second cell.

AChE, which is present on postsynaptic membranes, serves as the turn-off switch for this process; the reaction is stopped when AChE hydrolyzes ACh. Nerve agents act directly upon AChE. When a nerve agent inhibits AChE, it cannot perform its normal function of hydrolyzing ACh. ACh then accumulates, and the target cell's action continues uncontrolled, producing a clinical syndrome called cholinergic crisis.

Effects

The primary concern of the care provider when treating patients poisoned by nerve agents is to provide correct, timely, and lifesaving care. The first step in providing this care is to understand the effects that vapor or liquid nerve agent exposure has on the patient.

Nerve agent produces cholinergic crisis by inhibiting AChE and thus prolonging the action of ACh. The parts of the body that are affected by excessive ACh accumulation are:

- eyes
- nose (glands)
- mouth (glands)
- respiratory tract
- gastrointestinal tract
- cardiac muscle
- sweat glands
- skeletal muscles
- central nervous system

Eyes

Direct contact with a nerve agent vapor or aerosol produces effects on the eyes. When the agent's route of entry is through the skin or by ingestion, the effect on the eyes is delayed or may not occur. The main effect of the agent is to cause miosis, or pinpointing of the pupils. One or both pupils may be pinpointed and

unresponsive to light or darkness. Pinpoint pupils cause a complaint of dim vision that is more pronounced in low light conditions; soldiers may complain that everything "looks black," even in the middle of the day. Frontal headache, mild aching around the eye, or severe eye pains are common complaints in a soldier exposed to a moderate concentration of agent. About one patient in ten may complain of nausea. Twitching of the eyelids may be observed through the protective mask, and the eyes may be reddened. When a light source is used to test for pupillary response, the patient may complain of an ache behind the eyes due to light sensitivity.

Nose and Mouth

The secretory glands of the nose and mouth are as sensitive as or more sensitive than the eyes to nerve agent vapor or aerosol. If a soldier is poisoned by nerve agent liquid on the skin or through ingestion, the nose will become affected, but only in response to the whole body's (systemic) involvement. But if the patient is exposed to a nerve agent vapor or aerosol, the nose will begin to run immediately. This effect has been described by patients recovering from accidental nerve agent vapor exposure as "worse than a cold or hay fever" and "like a leaking faucet." Even after low concentrations of agent, runny nose (rhinorrhea) may be severe. The mouth will secrete saliva so copious that watery secretions run out the corners of the mouth.

Respiratory Tract

Inhalation of a small amount of nerve agent vapor will cause the patient to complain of tightness in the chest or shortness of breath (dyspnea). This occurs because the excessive ACh stimulates the muscles in the airways to contract and constrict the airways (bronchoconstriction). As the concentration increases, breathing difficulty will become severe (feeling like a severe asthma attack). One or two breaths of a high concentration of nerve agent vapor will cause gasping and irregular respirations within seconds to minutes. Cessation of breathing (apnea) can occur within minutes after exposure to a large amount of nerve agent, through either liquid on the skin or vapor inhalation.

Excessive bronchial and upper airway secretions (bronchorrhea) caused by stimulation of the airway glands by the excessive ACh will compound breathing difficulty. These secretions can obstruct the airway and cause difficulty in moving air into and out of the lungs.

Gastrointestinal Tract

After exposure to a large but sublethal concentration of vapor, the patient will complain of nausea and may vomit. Nausea and vomiting may also be the first effects from liquid nerve agent exposure on the skin. The patient may also complain of "heartburn" and pain in the abdomen, and he or she may belch frequently and have diarrhea or involuntary defecation and urination. These effects usually occur within several minutes after vapor exposure. However, after liquid agent exposure on the skin, these effects may lag in onset for as long as 18 hours after a sublethal exposure.

Cardiac Muscle

The heart rate can either increase or decrease after nerve agent exposure. Generally, blood pressure will increase, but blood pressure can rarely be determined in a contaminated area because the casualty and the care provider are in protective gear. The patient's heart rate will not aid the care provider in choosing the treatment for nerve agent poisoning.

Sweat Glands

The skin is very permeable to nerve agent. When penetration occurs after either liquid or vapor exposure, localized sweating occurs and progressively spreads over the surrounding skin area as nerve agent is absorbed. The likelihood that the care provider will be able to observe this localized sweating is minimal.

Skeletal Muscles

After exposure to a moderate or large amount of nerve agent, the patient will complain of weakness and twitching of muscle groups. The twitching can first be noticed at the site of a liquid

droplet on the skin. The muscles may show a rippling effect (fasciculation). As the nerve agent effect progresses, muscles can go into a prolonged contraction. However, instead of prolonged contraction, the large muscle groups may begin unsynchronized contractions that cause the arms and legs to flail about. The hyperactivity of the muscles in these instances leads to muscle fatigue and flaccid paralysis (being limp or unable to move). Without aggressive care, such a casualty will not survive.

The twitching caused by the direct effect of nerve agents on skeletal muscle may be difficult to distinguish from the tonicoclonic movements of convulsive seizures, but it is not a seizure. Seizures are caused by electrical discharges in the brain. A nerve-agent–poisoned patient who has been treated, has normal mental status, and is talking appropriately, but still has twitching, is most likely not seizing but suffering the skeletal muscle effects only.

Additionally, the skeletal muscle effects of nerve agents can worsen the patient's respiratory status by weakening or paralyzing the muscles of respiration, especially the diaphragm.

Central Nervous System

The effects of a large inhalation or liquid exposure on the brain and spinal cord are rapid and usually fatal under battlefield conditions. The soldier almost immediately loses consciousness, followed seconds later by seizure activity. Several minutes later, respiration ceases. Without immediate care, such soldiers will not survive to reach Role 1 treatment. Seizures may be present without motor activity, especially in a patient who has been either twitching or seizing for long enough that he or she has depleted the muscles of energy in the form of adenosine triphosphate.

When exposed systemically to low amounts of nerve agent, the soldier may complain of generalized weakness. Some people who survived low-dose exposures complained of nonspecific symptoms for weeks and have been described as having "post-neuro-syndrome." These symptoms include change in sleep pattern, mild memory losses, and new headaches. Some symptoms may be reflective of or indistinguishable from posttraumatic stress disorder.

Treatment

The most important care the casualty receives is given within the first several minutes after exposure (self-aid, buddy aid). Tables 1-3 and 1-4 show nerve agent effects, the onset time of these effects, and the required self-aid and buddy aid. These tables show the typical time course for mild, moderate, and severe nerve agent exposure. Immediate care, including administration of antidotes, can mean the difference between survival and death in a soldier exposed to a nerve agent. If aggressive care is not given to the patient exposed to a lethal concentration, death can result within 5 minutes after the appearance of symptoms.

It is imperative that every care provider understands the effects of nerve agents, the time in which effects occur, and the correct steps to treat the exposed soldier. The care provider must rapidly determine the following:

- extent of the poisoning,
- what medications have been administered,

Table 1-3. Nerve Agent Effects: Vapor Exposure

Mild • Eyes: miosis, dim vision, headache • Nose: rhinorrhea • Mouth: salivation • Lungs: dyspnea (tightness in the chest) • Time of onset: seconds to minutes after exposure	**Immediate Treatment** • *Self-aid:* one ATNAA • *Buddy aid*: stand by
Severe All of the above, plus • Severe breathing difficulty or cessation of respiration • Generalized muscular twitching, weakness, or paralysis • Convulsions • Loss of consciousness • Loss of bladder and bowel control • Time of onset: seconds to minutes after exposure	**Immediate Treatment** • *Self-aid*: none; soldier will be unable to help self • *Buddy aid:* three ATNAAs and diazepam immediately

ATNAA: antidote treatment nerve agent autoinjector

Table 1-4. Nerve Agent Effects: Liquid on Skin

Mild to Moderate • Muscle twitching at site of exposure • Sweating at site of exposure • Nausea, vomiting • Feeling of weakness • Time of onset: 10 minutes to 18 hours after exposure	**Immediate Treatment** • *Self-aid*: one to two ATNAAs, depending on severity of symptoms • *Buddy aid:* stand by
Severe All of the above, plus • Severe breathing difficulty or cessation of breathing • Generalized muscular twitching, weakness, or paralysis • Convulsions • Loss of consciousness • Loss of bladder and bowel control • Time of onset: minutes to an hour after exposure	**Immediate Treatment** • *Self-aid*: none; soldier will be unable to help self • *Buddy aid*: three ATNAAs and diazepam immediately

ATNAA: antidote treatment nerve agent autoinjector

- complications induced by the poisoning and/or resulting from conventional wounds, and
- if possible, route of exposure, liquid or vapor; liquid poisoning can delay onset of effects.

Self-Aid and Buddy Aid

All military personnel must know the signs and symptoms of nerve agent poisoning and the correct first aid in order to evaluate exposures and provide the appropriate self-aid and buddy aid. Timely and correct determination of the type of agent and route of entry causing the signs or symptoms is critical if the poisoned soldier is to survive to reach definitive medical care. Nerve agents will, under most field conditions, be encountered in both the vapor and liquid forms. When nerve agents are encountered and soldiers have donned protective equipment, a hasty self-evaluation for signs or symptoms of poisoning must be conducted. This self-evaluation implies that soldiers know the signs and symptoms of mild and severe nerve agent poisoning,

as well as the correct first aid. Decontamination eliminates nerve agents on the skin surface that could continue to be absorbed, causing a "time release" effect of symptoms.

Take the following steps for self-aid and buddy aid:

1. First, protect yourself by donning **mission-oriented protective posture (MOPP) level 4**.
2. Next, assist the casualty in **decontamination** of exposed skin in the following order:
   a. face
   b. neck area
   c. chest area
   d. abdomen
   e. arms and hands
   f. other exposed skin areas
3. **Administer drugs** following the guidelines below.

Drug Therapy

Atropine is the drug of choice for treating nerve agent poisoning. It will dry secretions (including those in the airways), reduce bronchoconstriction, and decrease gastrointestinal motility. (Note: use of atropine in the absence of nerve agent will cause the casualty to experience inhibition of sweating and heat storage problems in a warm climate.) Atropine will not relieve miosis, muscle twitching, or spasms, or increase diaphragm effort.

Pralidoxime chloride (2-PAM Cl) is the second drug for use in nerve agent poisoning cases. The 2-PAM Cl removes nerve agent (except soman) from AChE. This drug must be used as early as possible. Each ATNAA includes autoinjectors of 2.1 mg atropine and 600 mg 2-PAM Cl. Giving one ATNAA means injecting both drugs into the patient (Figure 1-1).

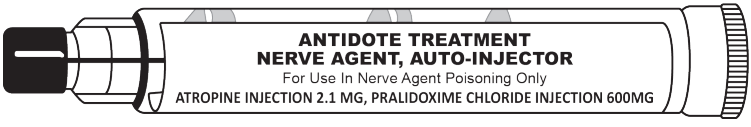

Figure 1-1. Antidote Treatment Nerve Agent Autoinjector (ATNAA).

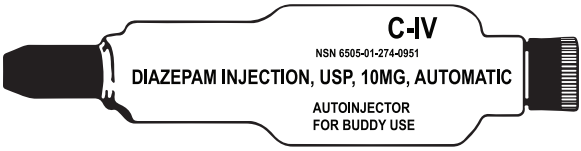

Figure 1-2. Convulsive Antidote, Nerve Agent (CANA) autoinjector.

Diazepam in the 10-mg autoinjector (CANA) is the drug adopted by the US military for use in controlling convulsing patients (Figure 1-2). If symptoms are severe, involving two or more organ systems (for example, the lungs and gastrointestinal tract), all three ATNAAs and one CANA should be given immediately to lessen the convulsive activity the soldier may experience. The key to increasing diazepam's effectiveness is administering it before convulsions begin. Diazepam is not for self-use. It should be given only to severe casualties via buddy aid. See illustrations for self and buddy aid in Figures 1-3 through 1-6.

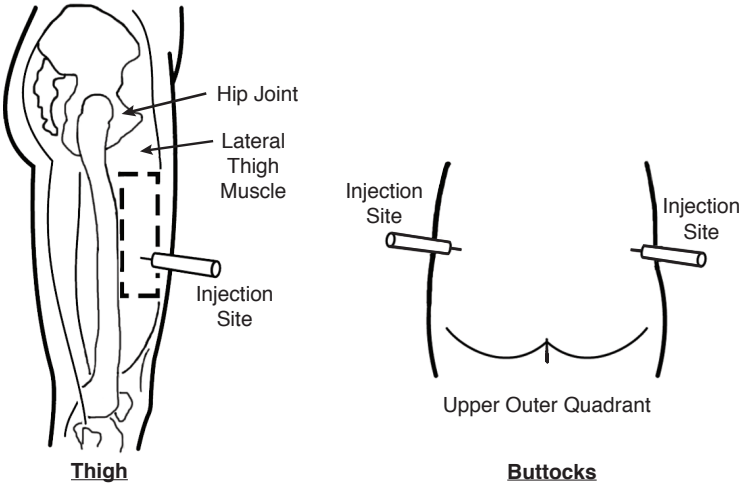

Figure 1-3. Primary (thigh) and secondary (buttocks) injection sites.

Figure 1-4. Self-aid injection.

Figure 1-5. Buddy aid injection.

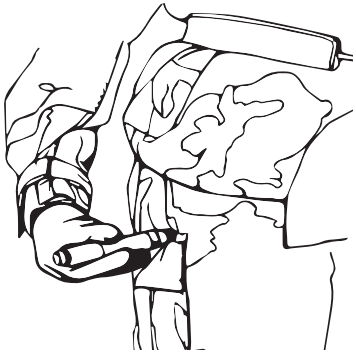

Figure 1-6. Hold the autoinjector like a pen.

Mild and Improving Symptoms (Especially Vapor-Only Exposure)

Observation is all that is needed for the casualty with mild symptoms, such as rhinorrhea, slight or recovering breathing difficulty, or excessive salivation that is decreasing. In the casualty with mild symptoms that appear to be clearing, one ATNAA administered during self-aid followed by observation for several hours, will normally be all that is needed.

In general, if there is suspicion that the patient may have had a liquid exposure, he or she should be observed for at least several hours and not returned to duty. The onset of symptoms after liquid exposures can be delayed by many hours.

Pain in the eyes, twitching of the eyelids, redness, and miosis cannot be treated in the field setting by the care provider. At the battalion aid station, eye pain can be controlled with atropine eye drops. These conditions, although annoying, are not life-threatening.

Severe Symptoms

When the effects progress to involve more than one organ system, the situation has changed from a mild to a severe exposure. Buddy aid in determining this transition is critical. As the change occurs, the remaining ATNAAs and one CANA autoinjector must be administered, as described above. Diazepam should always be administered when the three ATNAAs are given together. Self-aid or buddy aid must always be promptly followed with Role 1 medical care.

If the casualty is unconscious and in respiratory distress, ATNAAs and diazepam should be given immediately, followed by additional atropine. Atropine administered with the autoinjector will show some effectiveness in 3 to 5 minutes. Additionally, more atropine (2 mg) should be given every 2 to 5 minutes until the patient breathes easily without excess secretions complicating breathing. A total of 15 to 20 mg of atropine may be required in the first 1 to 3 hours after the onset of symptoms. Atropine will have a drying effect on salivation and rhinorrhea. During the time the atropine takes to reach maximum effect, the constriction and secretions in the airway and feeling of "tightness in the chest" will begin to decrease.

There is no upper bound to atropine use. Titrate for correction of breathing difficulties. At Role 2 and higher, more precise administration of additional doses of atropine will be possible through the intravenous (IV) route. Discontinue atropine when:

- Secretions of the mouth, nose, and lungs are minimized.
- The casualty says that breathing is easier, or it is easier to administer assisted ventilation.

If severe signs or symptoms persist 1 hour after using the three ATNAAs and the CANA, three additional 2-PAM Cl autoinjectors should be administered. The maximum 2-PAM Cl dose is six autoinjectors (3,600 mg) or two sets of three (6 total). IV 2-PAM Cl may be administered when available. Excess 2-PAM Cl may harm the casualty by dangerously raising blood pressure and causing laryngospasm. Never give more than three autoinjectors (or 2,000 mg IV) of 2-PAM Cl per hour. Discontinue the use of 2-PAM Cl after symptoms of respiratory distress have eased.

The doctrine for diazepam's use instructs the soldier to administer one CANA to his or her buddy immediately after using the third ATNAA in severe poisoning cases. The care provider may administer a second, third, or fourth CANA using the guidelines below.

After the first injection (buddy aid):

- Observe the casualty for about 2 minutes.
- Ventilate if necessary.
- Turn the casualty on his or her side to facilitate breathing.
- Pad areas to prevent other injuries.
- Restrain if necessary.
- If still convulsing after 2 minutes, give the second, third, or fourth CANA to stop seizures. Enough diazepam must be given to stop the seizures as soon as possible. Seizures cause brain damage and interfere with breathing. The longer the seizures last, the more difficult they are to stop and the greater the tendency for seizures to return. If the seizures do return, CANAs must be readministered until they stop again.

Like atropine for breathing, CANAs are titrated to stop seizures and prevent brain damage. Medical officers may give more diazepam, either intramuscularly or IV, if they deem it necessary.

Ventilation

Some severe nerve agent casualties will need assisted ventilation. Aggressive airway maintenance and the use of assisted ventilation will greatly increase the casualty's chances for survival. Providing assisted ventilation in a contaminated environment is possible using the Resuscitation Device, Individual Chemical (RDIC). The RDIC is a bag valve mask device that has an M40-style filter attached and is protected by a butyl rubber covering. By using this device, a casualty can survive to reach a care facility where mechanical ventilation is available. The soldier will not survive without this aggressive resuscitation.

Pretreatment

The US military has adopted the policy of pretreating soldiers against nerve agents' effect on AChE with pyridostigmine. The Food and Drug Administration approved the use of pyridostigmine bromide as pretreatment against GD in 2003. Soldiers may be issued a 14-day package with two blister packs of pyridostigmine tablets (Figure 1-7). Each blister pack contains 21 tablets, and each tablet contains 30 mg of pyridostigmine. When ordered by the unit commander, one tablet is taken orally every 8 hours. If a scheduled dose is missed, it is not made up; the soldier will take one tablet at the earliest opportunity to begin the next 8-hour interval. The soldier will discontinue taking the tablets on order from the unit commander. Doctrine allows commanders to renew the order once, for a total of 28 days.

Pyridostigmine bromide shields the AChE enzyme from the full effects of GD by providing reserve AChE. It prevents GD from permanently and irreversibly binding the enzyme, which it would otherwise do in 2 minutes. Pyridostigmine enhances the efficacy of 2-PAM Cl in GD casualties. The pretreatment does not increase the effectiveness of treatment for GB, GF, or VX. These

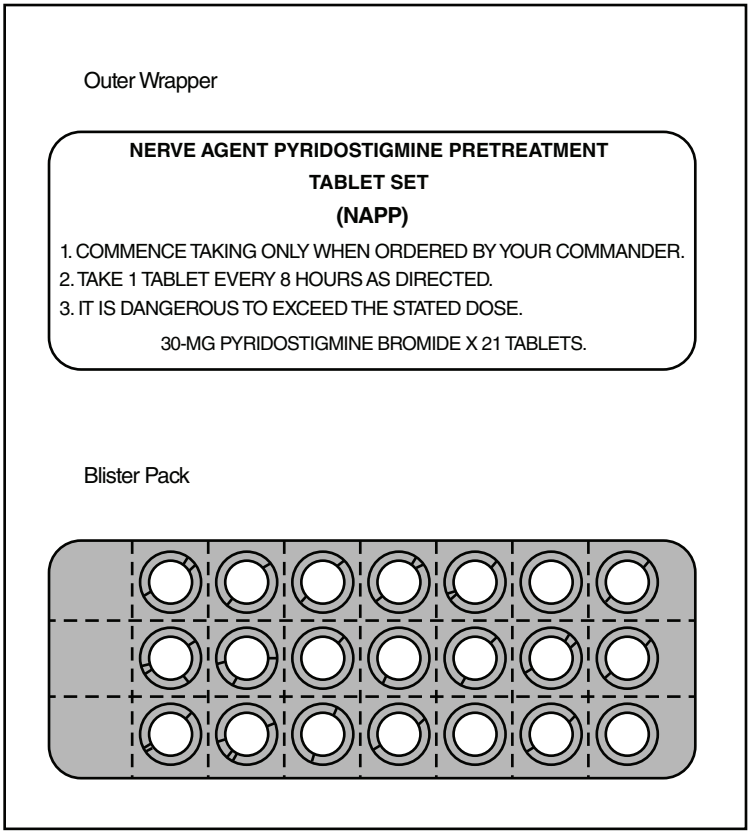

Figure 1-7. Blister pack of pyridostigmine tablets.

nerve agents also become irreversibly bound to AChE but require many hours to do so, and the binding does not affect therapy.

Pretreatment is not an antidote. Pretreatment alone will not protect the soldier and does not reduce the effects from the nerve agent. The effect of pyridostigmine bromide is to convert what would have been a lethal dose of GD into a dose that is survivable, but only if antidotes are promptly and correctly given. Instead of a dead soldier, pretreatment results in a sick one who requires treatment. When used in conjunction with ATNAA,

pyridostigmine enhances the effectiveness of ATNAA against GD only. It is critical that care providers understand that the effect of the pretreatment will have no effect on the severity of nerve agent poisoning symptoms. Therefore, an aggressive approach to care with antidotes is still warranted.

Common side effects of pyridostigmine bromide are increased bowel movements and abdominal cramping. In most cases these side effects decrease or resolve completely after a few days. If these or other symptoms persist, soldiers should see their care provider before going off the medication.

Chapter 2

VESICANTS

Summary

NATO Codes: H, HD, L, HL

Signs and Symptoms: Asymptomatic latent period (hours). Erythema and blisters on the *skin*; irritation, conjunctivitis, corneal opacity, and damage in the *eyes*; range from mild upper respiratory signs to marked airway damage; also gastrointestinal effects and bone marrow stem cell suppression. Fever not typical.

***Detection*:** Joint Chemical Agent Detector (JCAD), M256A1 Kit, M18A2 Chemical Agent Detector Kit, Individual Chemical Agent Alarm (ICAM), M90 Chemical Agent Detector, M8 and M9 Chemical Agent Detector Papers, M21 Remote Sensing Chemical Agent Alarm (RSCAAL), M93 series Fox Reconnaissance System, M272 Chemical Water Testing Kit, M22 Automatic Chemical Agent Detection Alarm (ACADA).

Decontamination: Reactive Skin Decontamination Lotion (RSDL), large amounts of soap and water, 0.5% hypochlorate solution.

Management: Immediate decontamination (< 2 minutes after exposure) is the only way to prevent damage. Symptomatic management of lesions.

Overview

Blister agents are second only to nerve agents as a concern to the US military. The primary blister agent threats are sulfur mustard (H, HD), lewisite (L), and a mixture of mustard and lewisite (HL).

Mustard remains a concern because it is both incapacitating and lethal, it is easy to manufacture, and there are large stockpiles. Mustard was the largest cause of chemical casualties in World War I, and it was used extensively by Iraq in the Iran-Iraq War in the 1980s. Although there were many mustard casualties in World War I, only about 3% of them died as a result of the exposure. This low death rate occurred despite the relatively poor protection and level of medical care available at the time (eg, antibiotics had not yet been developed).

Mustard rapidly penetrates the skin, causing both localized cellular damage and systemic damage. What makes mustard deadly is that a casualty exposed to a large amount of liquid or vapor mustard faces total systemic assault. The reasons for this are (1) failure of the body's immune system, with sepsis and infection as the major contributing causes of death, and (2) pulmonary damage, which is also a major contributory factor in death.

Physical Characteristics

The severity of blister agent effects will be affected, in part, by environmental conditions at the time of exposure. Warm, humid conditions increase the severity of blister agent damage and shorten the time of symptom onset. Cold weather retards the time of symptom onset and, providing the exposed skin remains cold, lessens the severity of blister agent damage.

Mustard has a freezing point of 58°F, while the mixture HL, containing 37% HD to 63% lewisite, has a freezing point of -3°F. HD's lower freezing point makes the mixture more significant in combat operations in a cold environment. Also, blister agents have a relatively high vapor density when compared to air. Mustard has a vapor density 5.4 times greater than air, lewisite has a density 7.1 times greater, and HL is 6.5 times heavier than air. The denser the vapor, the more likely it is to flow to low spots such as valleys, closed spaces, or the floor.

Mitigation

The care provider should use current intelligence and the physical characteristics of blister agents to determine likely exposure mechanisms (liquid and/or vapor) based on temperature. Utilizing all available data, the care provider can predict the chemical threat and take active steps to prevent or lessen the impact of chemical agent employment on individuals. This information, along with understanding the medical implications of an exposure, will allow the care provider to develop operational scenarios and anticipate the required response needed to optimize casualty care.

If the unit fails to conduct monitoring of personnel and equipment before either enters sleep or work areas, the potential exists for intoxication by multiple routes of exposure. Soldiers could absorb agent through the skin by handling equipment contaminated with a liquid agent. Vapors desorbing from equipment contaminated by liquid agent could affect the eyes and respiratory tract. When operating in cold climates or desert regions, particularly at night, use extreme caution to prevent contamination of warm-up tents, operations areas, or sleeping areas. An agent at its freezing temperature brought in on clothing or skin will liquefy as it warms and slowly produce vapors. Unless contamination is detected early, soldiers will be exposed in these confined spaces. Due to the freezing point of mustard and lewisite, it is critical to monitor personnel and their equipment in a warm-up tent before they occupy work or rest areas. Mustard, for example, has a freezing point of 58°F. Above 58°F the solid will transition to a liquid or gas, creating an exposure risk. All personnel in the monitoring tent must wear protective masks during monitoring.

Detection

Mustard received its name because of its garlic, horseradish, or mustard odor. It can be detected by smell, visual observation, and all current Defense Department chemical agent detectors. The human nose can detect mustard (H, HD) in concentrations of 0.6 to 1.0 mg/m^3 (although this may seem to be an undesirable

way to detect blister agent, alert soldiers will most likely smell the agent vapor before encountering the liquid). Detailed information on detection is provided in Chapter 11, Individual Protective Equipment. After release, H and HD appear as a thick, colorless, or pale yellow liquid, and HL appears as a dark oily liquid.

Some indicators of an attack in progress or contact with agent from a previously unknown attack are as follows:

- out-of-place smell of mustard, garlic, or onion;
- color change in M9 detector tape;
- color change in M8 detector card;
- overt indications such as enemy helicopters spraying liquid or indirect artillery fire that detonates with dull or muffled explosions;
- a feeling of oily "rain" as agent contacts exposed skin; and
- liquids that appear thick or oily and out of place on equipment, plants, or terrain.

Effects

H, HD. The major effects, onset, and severity of H and HD are shown in Table 2-1. Clinical signs and symptoms from mustard exposure are not apparent until hours later; however, tissue damage occurs within 2 minutes. Decontamination after the 2

Table 2-1. Effects of Mustard Vapor

Organ	Severity	Effects	Onset
Eye	Mild	Tearing, itchy, burning, gritty feeling	4–12 hours
	Moderate	Above, plus reddening, swelling of lids, moderate pain	3–6 hours
	Severe	Marked swelling of lids, possible cornea damage, severe pain	1–2 hours
Airways	Mild	Runny nose, sneezing, nosebleed, hoarseness, hacking cough	12–24 hours
	Severe	Above, plus severe productive cough, shortness of breath	2–4 hours
Skin	Mild to severe	Erythema (redness), blisters	2–24 hours

minutes of exposure will not prevent a mustard injury. Clinical effects occur on the skin and in the eyes and airways. Effects of severe exposure can occur days later in the bone marrow and gastrointestinal tract.

The effects on the skin are redness (erythema) that resembles sunburn and, later, blisters. The eyes initially are irritated and later may swell shut. The first airway effects occur in the upper airways (central airway compartment) with a hacking cough, hoarseness, and throat and nasal irritation. Severe agent exposure will later damage the lower airways. Inhaled HD will cause tissue to slough off in large sheets, known as pseudomembranes, which block the airway. The various degrees of central airway compartment obstruction may cause sneezing and coughing, hoarseness when talking, wheezing noises when breathing, or inability to breathe.

HL. The effect of HL liquid on the eyes and skin, or HL vapor in the eyes or respiratory tract, is immediate, causing intense pain and eyelid twitching. Casualties feel stinging pain within seconds after contact with liquid HL and will attempt to decontaminate themselves. Rapid decontamination is the only way to avoid severe burns. After 5 minutes of contact with HL, the upper layer of skin (epithelium) will die and appear gray. Painful erythema will begin shortly afterwards, and painful blisters may appear within 12 hours. Within an hour, edema of the conjunctivae and eyelids begins, which rapidly results in eye closure.

The immediate irritation from HL vapor is so intense that an individual will immediately mask or exit the area. Respiratory casualties will be unable to do either. Pulmonary effects are similar to those caused by mustard alone, except that pulmonary edema (fluid in the lungs) is more likely after lewisite exposure.

Self-Aid and Buddy Aid

The actions needed for self-aid or buddy aid are essentially nonmedical. Reacting as quickly as possible to warnings of an attack by donning a protective mask and going to mission-oriented protective posture (MOPP) level 4, detecting the agent as early as possible, and removing any suspicious liquid using

RSDL are the easiest ways to prevent a blister agent casualty. Reacting quickly to attack indicators will prevent most, if not all, casualty-causing exposures.

When exposure is suspected, time is critical. Unless the individual was wearing a protective mask at the time of the suspected exposure, the assumption must be that the eyes were exposed. Copiously flush the eyes with water to prevent or lessen the physical damage from blister agent exposure. Following the task in the *Soldier's Manual of Common Tasks* (STP 21-1-SMCT), individuals must decontaminate their own eyes, and although this is not a buddy-aid task, having assistance will increase the effectiveness of the procedure. Remember that time is critical for effective mustard decontamination because blister agents become "fixed" to tissue components within 2 minutes after deposition. Also use RSDL as soon as possible to remove agent from hands and around the eyes.

Immediate Casualty Decontamination

As described above, self-aid decontamination must be done at the time of exposure. The casualty should have performed skin decontamination with RSDL and equipment decontamination with the M295 Individual Equipment Decontamination Kit before being seen by the care provider. Because of the persistent nature of blister agents, patient decontamination must be as thorough as possible. As with nerve agent exposure, care providers must protect themselves by masking and donning MOPP gear. When beginning treatment, attempt to determine what type of decontamination has been done and when. Understanding the potential contamination threat posed by the casualty will allow the care provider to avoid cross contamination. Decontamination performed within 2 minutes reduces the toxic effects by more than 50%. Decontamination is explained in detail in Chapter 10, Patient Decontamination Station.

Field Treatment

Initial medical treatment by the care provider at the time of exposure is limited. The actions required at the unit level medical treatment for blister agent casualties are two-fold: (1) triage for

evacuation or return to duty, and (2) the actual treatment of the casualty. Triaging the soldier is based on several factors: the severity of observable effects, the opinion of the triaging care provider as to whether or not the effects will progress further, and the impairment of normal duty requirements caused by the symptoms.

Casualties with signs or symptoms that appear at the earliest onset time possible (see Table 2-1) generally require evacuation to a medical treatment facility (MTF), with little chance for quick return to duty, because the initial effects will progress. Fast onset of symptoms can indicate exposure to high concentrations of agent, causing severe lesions, for which the care available at an MTF is required.

Eyes. Individuals with mustard conjunctivitis require application of a steroid antibiotic eye ointment. FM 4-02.285, *Multiservice Tactics, Techniques, and Procedures for Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, recommends dexamethasone sodium phosphate-neomycin ophthalmic ointment for this use. This drug decreases inflammation and has antibacterial effects. Systemic narcotic analgesics are recommended for eye pain. Under no circumstances should the eyes be bandaged because it may cause the eyelids to stick together, the secretions will not have a means to drain, and the resulting accumulation in the conjunctival sac can lead to infection and corneal ulcerations. Individuals presenting with blister agent conjunctivitis require evacuation to an MTF for treatment by an ophthalmologist as soon as possible. Petroleum jelly or antibiotic ointments should be placed on the eyelashes to prevent abscess formation.

Skin. Evacuate individuals presenting with erythema that limits motion in a limb. Also, patients with erythema covering more than 5% of the body in noncritical areas, using the "rule of nines" to determine the coverage (Figure 2-1), require evacuation. Individuals with erythema involving less than 5% of the body may need evacuation, depending on the location of the erythema and the resulting duty impairment. Treat erythema as needed for itching and burning sensations. Application of a topical steroidal cream or calamine lotion will provide temporary relief.

1. Head and neck: 9%
2. Anterior trunk: 18%
3. Posterior trunk: 18%
4. Upper extremities: 18% (9% each)
5. Lower extremities: 36% (18% each)
6. Perineum: 1%

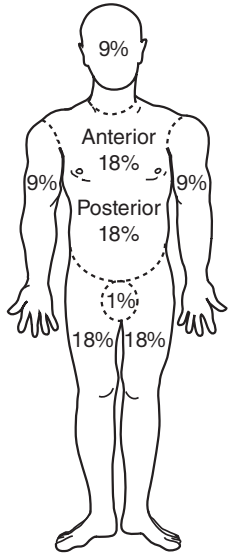

Figure 2-1. Rule of nines.
Figure reproduced from: *Emergency War Surgery*. 4th US Revision. Fort Sam Houston, TX: Borden Institute; 2013: Fig. 28-2.

Normally erythema progresses to vesication (blister formation). The size and number of blisters depends on the severity of exposure, skin condition (sweaty and moist or dry) at the time of exposure, and location of the exposure on the body. If possible, blisters the size of a quarter or smaller should be left intact because they act as a protective cover over the wound, providing good protection from infection. The blister fluid is sterile and does not contain live agent. Small unbroken blisters should be covered with a petrolatum gauze bandage. The dressing should be changed every 3 to 4 days.

Large blisters should be unroofed, and blisters that have broken should have the ragged blister roof removed. The area of the open blister should be cleaned with tap water or saline and a petrolatum gauze bandage should be applied. The primary concern when treating blisters of any size is preventing infection.

The decision to evacuate casualties or return them to duty must not be made on the basis of blister formation only. Initial blister formation may be slight, but over time the condition could progress to large blisters that are unmanageable in the field. If a casualty is not evacuated, the care provider must instruct the individual on self-aid care for the blister. The individual should be given a topical antibacterial cream, such as 10% mafenide acetate or silver sulfadiazine burn cream, and instructed to apply a 1/8-inch layer to the blister four times a day. A petrolatum gauze bandage should then cover the area.

Lungs. Soldiers who present with any sign or symptom of respiratory exposure should be evacuated promptly. The care provider cannot determine damage to the larynx or trachea. Any unnecessary delay in diagnosis and required treatment at the MTF must be avoided. If the airway is obstructed by blisters, the blisters may be unroofed when surgical and supportive care is available.

Chapter 3

CYANIDE

Summary

NATO Codes: AC, CK

Signs and Symptoms: *AC:* Headache, dizziness, nausea, sweating, rapid breathing, minor eye and skin irritation, rash. *CK:* As above with more pronounced skin and eye irritation and intolerable tearing. Exposures to high concentrations of either agent will rapidly cause seizures and respiratory and cardiac arrest.

Field Detection: Joint Chemical Agent Detector (JCAD), M256A1 Chemical Agent Detector Kit, M18A2 Chemical Agent Detector Kit, and M90 Chemical Warfare Agent Detector detect hydrogen cyanide (AC) as vapor or gas in the air, and the M272 Chemical Agent Water Testing Kit detects AC in water.

Decontamination*:* Skin decontamination of AC is usually not necessary because the agent evaporates rapidly. CK should be decontaminated with water or other standard non-bleach decontaminants. CK and hypochlorite will produce a violent chemical reaction. Contaminated clothing should be removed and disposed of.

Management: *Antidote*: intravenous sodium nitrite and sodium thiosulfate. *Supportive*: oxygen, correct acidosis.

Overview

The two cyanide agents (also known as cyanogens and blood agents) of most concern are hydrogen cyanide (AC) and cyanogen chloride (CK). These agents kill by disrupting oxygen utilization at the cellular level.

Physical Characteristics

AC is highly volatile and lighter than air, which causes rapid vaporization of the liquid following release and minimizes the likelihood of a liquid exposure under most conditions. The vapor expands outward, rapidly lowering air concentration. CK is less volatile than AC and heavier than air, allowing it to cling to the ground near the point of delivery and flow into low areas (such as foxholes). However, within a short time neither agent will pose a serious threat downwind from the release point due to rapid dissipation. The M45 and M50 protective mask filters should be exchanged following exposure to AC or CK.

Detection

The only detection available to the soldier is the M256A1 Chemical Detection Kit (explained in detail in Chapter 11, Individual Protective Equipment). The first indication of contact with AC might be the smell of bitter almonds, but only approximately half of the population are able to detect the odor of cyanide, so odor should never be relied upon as a means of detection. CK has a bleach-like odor, but the initial effects of CK poisoning (mucous membrane irritation, tearing) can occur at exposures too small for a human to smell the agent, so again, odor is not useful as a means of detection or identification.

Effects

Death can occur within minutes after exposure to a high concentration of cyanide gas. Lower concentrations will produce a slower onset and/or more limited scope of effects. The major

Table 3-1. Effects From Cyanide (AC and CK) Vapor Exposure

Exposure	Signs and Symptoms	Course	Time
Moderate, from low concentration	Transient increase in rate and depth of breathing, dizziness, nausea, vomiting, headache.	These may progress to severe effects if exposure continues.	The time of onset of these effects depends on the concentration but is often within minutes after onset of exposure.
Severe, from high concentration	Transient increase in rate and depth of breathing, in 15 seconds. Cessation of respiration, in 2 to 4 minutes. Cessation of heartbeat, in 4 to 8 minutes.	Death if untreated.	Within seconds after onset of exposure.

signs and symptoms are shown in Table 3-1. In addition, severe exposure to CK may cause eye and skin ulcerations, full thickness burns, and serious damage to the airways. These chlorine-related symptoms may progress even after the symptoms from the cyanide component of the agent have abated.

Self-Aid and Buddy Aid

The only self-aid for AC and CK is to don a protective mask. The only buddy aid for AC or CK exposure involves helping a soldier mask and then removing the victim from the contaminated site.

Care Provider Actions

The symptoms shown in Table 3-1 may occur within moments and lead to death within minutes.

Rapid evacuation and administration of cyanide antidote therapy will greatly improve survivability.

Use of intravenous antidotes in a contaminated field environment may not be possible. However, the first step is to utilize inhalable nitrites (amyl nitrite "poppers"). Amyl nitrite is available in premeasured vials. If it is safe to do so, the mask seal

may be broken momentarily to allow the placement of a nitrite inhalant tab inside the protective mask. Oxygen, if available, will also help reverse the symptoms of cyanide poisoning.

An exposed casualty who can walk and talk 5 minutes after removal from exposure has an excellent chance of survival.

Chapter 4

LUNG-DAMAGING AGENTS AND TOXIC INDUSTRIAL CHEMICALS

Summary

NATO Codes: CG, Cl

Signs and Symptoms*: Central effects:* Eye and airway irritation, dyspnea. *Peripheral effects:* Chest tightness and delayed pulmonary edema.

Field Detection: Joint Chemical Agent Detector (JCAD). The M18A2 Chemical Agent Detector Kit and the M93 series Fox Reconnaissance System will detect small concentrations of CG; however, they will not detect Cl.

Decontamination: *Vapor:* fresh air; *liquid:* copious water irrigation.

Management: Termination of exposure, ABCs of resuscitation (airway, breathing, circulation), enforced rest and observation, oxygen with or without positive airway pressure for signs of respiratory distress, other supportive therapy as needed.

Overview

Over 1,800 toxic industrial chemicals (TICs) are used in industry, stored at industrial sites, and transported on the world's road and rail systems. Some of these chemicals were deployed as chemical warfare agents during the First World War, killing and injuring thousands, and can have the same deadly consequences today if released during an accident or through terrorist sabotage. Death

from exposure to TICs is more frequent when they are inhaled. Inhaling a TIC in the form of a gas, vapor (gas coming from a liquid), or aerosol (liquid or solid particles suspended in a gas) can cause a sudden closure of the larynx (laryngospasm), causing the victim to choke and collapse. TICs can also cause damage to the tissues of the upper airways, resulting in swelling, scarring, and airway narrowing, which can restrict breathing. TICs can damage lung tissues, allowing body plasma and other fluids to leak into the lung air sacs (alveoli), causing pulmonary edema and death from asphyxiation.

Exposure to TIC lung-damaging agents can occur on and off the battlefield. The care provider must know how to identify the signs and symptoms and provide appropriate lifesaving support to those exposed to these agents.

Understanding the Respiratory System

The respiratory system can be divided into two compartments. Understanding these compartments can greatly simplify the treatment problem-solving process (Figure 4-1).

The central airway compartment includes the nasopharynx (nose), oropharynx (mouth), larynx (vocal cords), and the trachea and bronchi (airway from the throat into the lungs). Tissues in this area are very moist and thin and can be damaged by TICs.

The peripheral lung compartment includes the lung sacs (alveoli) distributed throughout the lung tissue. During normal respiration, inhaled gases fill the alveoli and then move slowly through their walls. The gases then move through the thin walls of the blood vessels (capillaries) surrounding the alveoli and into the blood. TICs can damage the walls of alveoli and the capillaries surrounding them, allowing blood plasma and cells to leak into the air space of the alveoli.

Types of Lung-Damaging Agents

TICs are numerous. Those that pose a frequent threat to the soldier in the field are listed here. Though the list is not complete, casualties from other lung-damaging agents are managed the same way as in these examples. In low doses, highly reactive TICs

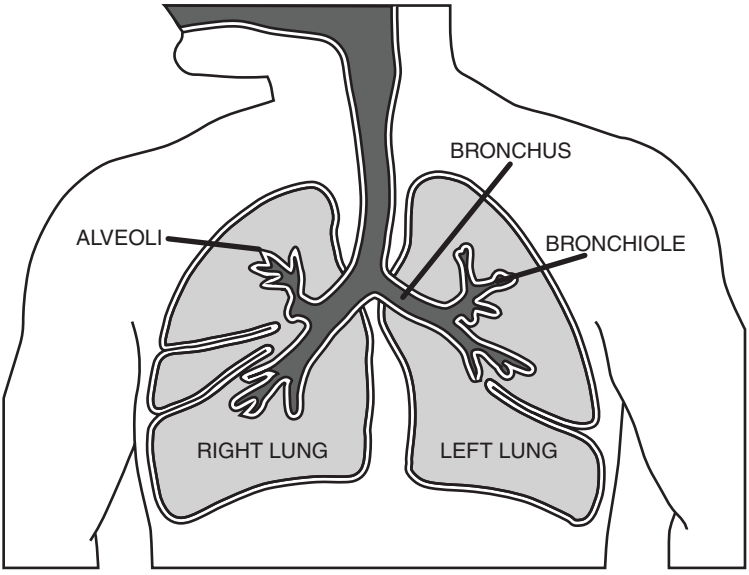

Figure 4-1. Central airway (dark gray) and peripheral airway (light gray).

have a greater effect on the central airway compartment; other TICs act on both airway compartments; and still others that are not as reactive in the central airway compartment travel deeper in the respiratory tract and destroy the tissues of the alveoli in the peripheral lung compartment. Any TIC inhaled in large doses will cause damage to both central airway and peripheral lung compartments.

Centrally Acting TICs

Ammonia is a highly caustic and reactive gas used for industrial refrigeration, cleaning, processing of some illicit drugs, and numerous legitimate industrial processes. It is a good example of a TIC that, in low doses, is primarily centrally acting. It rapidly forms a strong base (alkali) when it contacts the moist tissues of the central airway compartment. The alkali burns and destroys the tissues it contacts. The victim may suddenly go into

laryngospasm and collapse. The tissues of the compartment will also become swollen. Scar tissue may form along the airway. Frequently, damaged tissue in the airway will die and slough off, obstructing the airway.

Sulfur mustard (HD) is an example of a chemical agent produced solely for warfare that acts on the central airway compartment if inhaled. HD will cause tissue to slough off in large sheets, known as pseudomembranes, which block the airway. The various degrees of airway obstruction may cause sneezing and coughing, hoarseness when talking, wheezing noises when breathing, or inability to breathe.

Peripherally Acting TICs

Phosgene is a major industrial chemical used in many manufacturing processes. More importantly, it is released from heating or burning many common chemicals or solvents. Carbon tetrachloride, perchloroethylene (a degreasing compound), methylene chloride (used in paint removal), and many other compounds break down to phosgene with flame or heat. Also, common substances such as foam plastics release phosgene when they burn. A soldier presenting with shortness of breath in the absence of a chemical attack or other obvious cause should be carefully questioned about whether he or she has been near any burning substances or chemical vapors near flame or other hot materials (eg, a heater with open coils).

Perfluoroisobutylene (PFIB) is given off when Teflon (DuPont, Wilmington, DE) burns at high temperatures, such as in a vehicle fire. Teflon is used to line the interior of many military vehicles, particularly armored vehicles and aircraft. Closed-space fires in these vehicles release PFIB. Survivors of vehicle fires who are short of breath should be questioned about their exposure to the smoke.

Oxides of nitrogen, or NOx, are components of photochemical smog that can be produced by burning gunpowder or industrial waste. These substances can build up to high concentrations where artillery is fired and there is inadequate ventilation. Soldiers who become short of breath after heavy firing should be suspected of exposure to this lung-damaging agent.

HC smoke is a mixture of equal amounts of hexachloroethane, zinc oxide, and approximately 7% grained aluminum or aluminum powder used in the military for obscuration. Zinc oxide can cause lung damage if inhaled in toxic amounts. Appropriate precautions, such as wearing protective masks, must be taken when HC smoke is used.

TICs That Act Both Centrally and Peripherally

Chlorine is a good example of a combination agent, one that acts on both airway compartments in low doses. It is widely used in industry for manufacturing plastics and lubricants and purifying water. It was the first chemical agent used effectively on World War I battlefields against unprotected military troops. Its effectiveness as a weapon was greatly reduced once protective masks were widely available for wear on the battlefield. Chlorine turns to hydrochloric acid when it contacts the moisture of the airway; it then causes chemical burns to the tissue. It produces signs and symptoms seen with exposure to both central and peripherally acting agents. Its action is a reminder that even though central compartment damage may seem like the primary concern in some patients (when they are coughing and wheezing), the medic must always treat casualties as if they could develop peripheral compartment symptoms, and take seriously any patient complaints about chest tightness or breathing difficulty.

Detection

There are no specific field detection devices for chlorine and ammonia. However, each has a distinctive odor: chlorine has an acrid or unpleasantly pungent odor, and ammonia has a pungent odor. Phosgene smells like newly cut grass, newly mown hay, or green corn. Unfortunately, odor is not a reliable detection method (if you can smell these gases, you are being exposed to their toxic inhalation effects).

Protection

Both the military protective mask fitted with a C2A1 filter canister, and the Joint Service General Purpose Mask with M61 filters, will protect against chlorine, phosgene, PFIB, NOx, and HC smoke in the open battlefield. Specific filters, or the use of a self-contained breathing apparatus, are mandated for other TICs, such as ammonia. Masks do not protect against carbon dioxide. Masks will not be effective in environments where the TIC displaces oxygen, creating a low oxygen environment (at or below 19.5% fraction of expired oxygen [FiO_2]). Masks should be used in these environments for escape purpose only. Using a self-contained breathing apparatus is recommended.

Physical Properties

Lung-damaging TICs are typically heavier than air and hang close to the ground when released. They tend to evaporate and disperse very quickly depending on temperature and wind conditions. If the TIC is in liquid form at room temperature, it will tend to give off a vapor. Vapors can become trapped in clothing fibers and "off-gas" to affect nearby individuals who have no respiratory protection. Although skin decontamination after vapor exposure is not a high priority, clothing should be removed and the underlying skin decontaminated with soap and water.

Mechanism of Action

Central Airway Compartment

Centrally acting TICs, such as ammonia and HD, will form strong acids or bases (alkali) with the water in the tissues of the central airway and then destroy these tissues. Damaged tissues will swell and can slough into the airway, obstructing breathing.

Peripheral Airway Compartment

Phosgene is the most studied peripherally acting agent. It causes pulmonary edema, which is life threatening. Less is known about the other compounds; however, they are believed to be very

similar. Phosgene causes effects in the lung by inhalation only. It does not cause lung effects when absorbed through the skin, injected, or orally ingested.

When inhaled, phosgene travels to the very end of the smallest airways, the bronchioles, and causes damage to these airways. Additionally, it causes damage to the thin membrane that separates the smallest blood vessels (capillaries) and the air sacs (alveoli), the alveolar-capillary membrane. Phosgene reacts with proteins and enzymes in the alveolar-capillary membranes to cause damage to the membranes. These membranes usually function to separate the blood in the capillaries from the air in the alveoli, but when the membranes are damaged, they cannot perform this function. Blood, or at least the liquid part of the blood (plasma), can leak through the damaged membrane into the alveoli. When the plasma leaks into the alveoli, the air sacs become full of fluid, and air cannot enter them. Therefore, exchange of oxygen from the air into the blood is hindered, and the casualty suffers oxygen deprivation. The extent of oxygen deprivation depends on the extent of the phosgene exposure and the number of alveoli filled with plasma. This is similar to what happens in drowning, in that the alveoli fill up with fluid. However, in this instance, it is fluid from the blood, not from an external source. For this reason, phosgene poisoning is sometimes referred to as "dry land drowning."

Clinical Effects

Centrally Acting Agents

Immediately or shortly after exposure to these gases or vapors, the individual may develop laryngospasm (laryngospasm does not occur in all exposures). As the airway compartments are irritated and damaged, the individual will sneeze, will feel pain in the nose (nasopharynx inflammation), and may develop painful swallowing (oropharynx inflammation), hoarseness, a feeling of choking, noise with inhalation or exhalation (larynx inflammation), pain in the chest, coughing, and wheezing during breathing (trachea and bronchi inflammation). If the exposure has been enough to cause the TIC to reach the peripheral airway

compartment, effects in the peripheral compartment may follow. Scarring of the central airway compartment can create permanent airway narrowing, depending on the agent involved and the dose received.

Peripherally Acting Agents

Very shortly after exposure to phosgene or other agents affecting the peripheral airway, the casualty will typically have an asymptomatic period of 30 minutes to 72 hours, but most significant exposures involve a latent period of less than 24 hours. The duration and concentration of the exposure will determine the time to symptom onset. The casualty may notice irritation of the eyes, nose, and throat, but more commonly there will be no effects during or immediately after exposure. The major effects from phosgene exposure (and the other compounds), like the effects from mustard, do not occur until hours later.

The casualty will notice shortness of breath (dyspnea) between 2 and 24 hours after exposure. Initially, this may be mild, and the dyspnea's eventual severity will depend on the amount of exposure. As the damage progresses, dyspnea will become more severe, and soon a cough will develop. If the damage is severe, the casualty will start coughing up clear, foamy sputum (blood plasma that has leaked into the alveoli).

With a very mild exposure to phosgene (or another of these compounds), casualties will develop dyspnea 6 to 24 hours after exposure. They will notice it first after heavy exertion; however, later they will become short of breath after any activity. With proper care, these casualties will do well and recover completely.

A casualty with a severe exposure to phosgene (or another of these compounds) will notice shortness of breath within 4 to 6 hours after exposure. Increased difficulty breathing, even at rest, will occur, and despite intensive pulmonary care, the casualty may not survive.

The average casualty exposed to a lung-damaging agent will be in between these two extreme cases. When the onset of dyspnea is more than 6 hours after exposure, there may be

progression to dyspnea at rest. However, with good pulmonary care beginning early after the onset of effects, the casualty should recover completely.

Field Care

The care provider should be alert to the possibility that patients can be exposed to lung-damaging agents even when battlefield agents are not being used. Exposure to hazardous, lung-damaging TICs is a likely possibility from industrial sabotage, from exposure to the smokes from burning vehicles, and during common military operations.

A casualty who complains of shortness of breath should be questioned extensively about exposure to smoke from burning Teflon, gunpowder, or industrial chemicals. The most important things to do for such casualties are to ensure they are free from contamination (out of the smoke or wearing a mask) and are kept completely at rest (preferably placed on a litter so they do not walk). Even small exertions can greatly intensify the effects of these agents and speed the progress of pulmonary edema. A casualty who is short of breath may require oxygen, assistance with a continuous positive airway pressure device, or intubation and mechanical ventilation with oxygen.

Those suspected of exposure to a lung-damaging TIC should be observed for 24 to 36 hours, even if they do not have immediate difficulty breathing. Those with a complaint of chest tightness should immediately be made to rest. A dyspneic casualty must be evacuated as quickly as possible to a medical facility that can provide intensive pulmonary care, because the patient's condition can rapidly deteriorate once the lungs begin to fill with fluid. Survival is less likely for a casualty who becomes dyspneic within the first 4 hours after exposure, because pulmonary edema is already rapidly occurring. The casualty will certainly not survive without proper pulmonary care. A casualty who first experiences breathing difficulty more than 4 hours after exposure has a good chance of survival if appropriate medical care is provided.

Chapter 5

RIOT-CONTROL AGENTS

Summary

NATO Codes: CN, CS, CR, OC, DM

Signs and Symptoms: Burning and pain on exposed mucous membranes and skin, eye pain and tearing, burning in the nostrils, respiratory discomfort, and tingling of the exposed skin. DM will cause prolonged periods of vomiting and a feeling of malaise.

Detection: No field detector is available for any of the riot-control agents.

Decontamination: *Eyes:* Thoroughly flush with water, saline, or similar substance. *Skin (CS, CN, CR, DM):* Flush with copious amounts of water, soap and water, or a mildly alkaline solution (sodium bicarbonate or sodium carbonate). Generally, decontamination is not needed if the wind is brisk. *Skin (OC):* The pain from OC will increase with water, especially warm water. It is best decontaminated with baby shampoo, milk, alcohol, or vegetable oil. Without decontamination pain will subside over time.

Management: Usually none is necessary; effects are self-limiting and diminish or cease within 45 minutes. DM is the exception; its effects may last several hours.

Overview

Riot-control agents irritate the skin, mucous membranes, and airways, causing individuals to be unable to perform their normal duties as a result of the discomfort. Riot-control agents have been called irritants or tearing agents and are typically characterized by a very low toxicity and short duration of action. In rare cases, serious injuries may occur.

Chloropicrin (a lacrimator that can be life-threatening) was initially synthesized in 1848 and was used in World War I as a tear gas and insecticidal fumigant. Farmers have used chloropicrin to eradicate soil-borne diseases and pests before a crop is planted for more than 50 years.

CS, CR, CN, and OC are agents frequently used today for riot control because of their high safety ratio (the lethal dose far exceeds the dose needed to cause irritating effects). OC is commonly used by police with individuals and small crowds, and CS is used for dispersal of large crowds. CS is sometimes used for military mask confidence training. Exposure to riot-control agents has occurred during the excavation of buried containers of agent on military reservations, and also when individuals have entered areas where large amounts of agent were previously released and the residue remained.

Physical Characteristics

As a group, the riot-control agents CN, CS, CR, and DM are solid crystalline powders that can be suspended in a liquid and aerosolized. Oleoresin capsicum (OC), from cayenne peppers, is not a solid but a resin that can be mixed in a liquid solution. Table 5-1 lists characteristics of these agents.

Detection

There are no detectors for riot-control agents.

Table 5-1. Riot-Control Agent Characteristics

Agent	Other Names	Physical Properties at Standard Temperature	Dispensing Method, Color, Odor
CN	Mace (Mace Security International, Cleveland, OH)	aerosolized crystalline solid	Liquid spray (with solvent), explosive dispersal or in a smoke-generating mixture. White smoke cloud. Odor like apple blossoms.
CS		aerosolized crystalline solid, flammable	Liquid spray (with solvent), explosive dispersal, or smoke-generating mixture. White smoke cloud. Pungent pepper odor.
CR		white or yellow solid	Aerosolized powder from grenades or added to a liquid solution. White cloud and powder produced. Pepper-like odor.
DM	adamsite	yellow-green crystalline solid	Explosive dispersal or particulate smoke from a heat-generating device. Canary yellow cloud. Colorless as it dissipates. No odor. Irritating to airways.
OC	pepper spray	Sticky resin suspended in a solvent	Liquid or foam spray. Colorless resin suspended in solvent. Odorless unless scented.

Effects

The agents CN, CS, and CR irritate tissue immediately, causing the eyelids to spasm shut and producing temporary discomfort, including pain in the eyes, copious tearing, sneezing, and a heavy nasal discharge. Airway irritation causes coughing and shortness of breath. Exposure to significant amounts of CN, CS, or CR

can cause skin redness and blistering. DM is unique in that its effects are delayed for several minutes, and exposure will cause skin discomfort, vomiting, and mental malaise and depression. OC is unique in its mechanism of action. OC contains capsaicin in large concentrations, which causes the mass release of the neurotransmitter substance P. This causes an overwhelming sensation of pain until the body's store of substance P is depleted.

Self-Aid and Buddy Aid

The first action is to remove the individual from the aerosolized cloud of CN, CS, CR, or DM. A wet cloth over the nose and mouth can help reduce the number of aerosolized particles inhaled. Don a protective mask if available. Special protective clothing is not essential. Street clothing that covers the arms and legs will help to protect the skin from contact with the agent. If an exposure occurs in a well-ventilated area, severe skin and lung irritation is unlikely. High-dose exposure, for example, when an individual is in the agent cloud for prolonged periods in a confined space, can cause skin blistering, upper airway difficulties, and laryngospasm if protective garments and respirators are not worn. In large doses, DM will cause vomiting and mental depression lasting for several hours after exposure. OC is dispensed as a liquid or foam spray containing resins that stick to the skin. Dabbing the agent with a cloth may help to reduce the amount of OC resin on the skin. The pain from OC will recede over time without decontamination.

Care Provider Actions

Medical treatment provided by the care provider reinforces self-aid. Normally the eyes will become bloodshot and red. Wash the eyes with baby shampoo and rinse with copious amounts of water to help reduce the eye pain. If particles of a crystallized agent get into the eye, irrigate with copious amounts of water and treat with antibiotic eye ointments. Pieces of exploding canister can also damage the eye. Treat impaction cases according to eye injury protocols with direct follow-up by an ophthalmologist. Open blisters on the skin can be irrigated with sterile saline and

covered with antibiotic ointment. Inhalers and supplemental oxygen should be administered to patients with exacerbated breathing difficulties, such as asthmatic conditions. Irritated skin can be washed with a mild baking soda solution to normalize pH.

Casualty Decontamination

No decontamination is required with most exposures to CN, CS, CR, or DM. To remove the dry agent from clothing and hair, individuals should move briskly in a well-ventilated area with eyes and mouth closed, while flapping their arms and rubbing their hair. After heavy exposures, individuals can decontaminate themselves with soap and water, although water may reactivate OC on the skin and cause pain. A continuous water flow must be used. For OC decontamination, it is best to wash with baby shampoo, milk, or vegetable oil to help break up the resin and neutralize the agent's action.

Chapter 6

INCAPACITATING AGENTS

Summary

NATO Code: BZ

Signs and Symptoms: Mydriasis, dry mouth, dry skin, increased deep tendon reflexes, decreased level of consciousness, confusion, disorientation, disturbances in perception and interpretation (illusions and/or hallucinations), denial of illness, short attention span, impaired memory.

Field Detection: No field detector is available.

Decontamination: Gentle but thorough flushing of skin and hair with water, or soap and water, is all that is required. Remove clothing.

Management: *Antidote:* physostigmine. *Supportive:* monitoring of vital signs, especially core temperature. Position patient to protect airway until effects of central respiratory depression diminish.

Overview

Incapacitating agents are chemical substances designed to act on the central and peripheral nervous system to inhibit an individual's ability to perform work or complete the mission. Several categories of agent can achieve these deleterious effects, but BZ will be highlighted in detail because it has been weaponized in the past. Other types of incapacitating agents include:

- **irritants**, such as riot-control agents (CS, CN), pepper spray;
- central nervous system **stimulants**, such as amphetamines, cocaine, caffeine, and nicotine;
- central nervous system **depressants**, such as barbiturates, narcotics, antipsychotics, and benzodiazepines;
- **psychedelics**, such as lysergic acid diethylamide-25 (LSD), 3,4-methylenedioxy-methamphetamine ("ecstasy"), and phencyclidine (PCP); and
- **deliriants**, such as anticholinergics (BZ, Agent 15).

Many of these agents have been studied as incapacitating agents in the past and may again be agents of interest in the future.

Physical Characteristics

BZ is a crystalline solid at standard temperature and pressure. Its high melting point (150–152°C/302–306°F) makes it ideal for dispersal in explosive munitions. Suspended in solvents, it can contaminate food or be absorbed through the skin.

Detection

There are no detectors for these agents.

Effects

"Dry as a bone, red as a beet, hot as a hare, and mad as a hatter."

BZ interferes with the cholinergic synapses in the central nervous system, causing disruptions of memory, problem solving, attention, and comprehension. Signs of anticholinergic poisoning progress as follows:

- increased body temperature ("hot as a hare");
- lack of sweating, causing the skin to be dry to the touch ("dry as a bone") and red ("red as a beet"); and
- slurred speech, stumbling gait, slowness of movement and thinking, and delirium ("mad as a hatter").

Patient delusions are characteristically based on real objects; for instance, they may see someone's hand as holding a hamburger and bite the person's hand, they may shoot at clouds thinking they are flocks of ducks, or they may hide, thinking small animals or shadows are large, wild animals. Movement will be clumsy and thinking slowed. Symptoms such as delirium are seen several hours after exposure and progress in intensity for several days until the toxin is eliminated from the body in the urine and recovery begins.

Self-Aid and Buddy Aid

Those exposed to BZ have difficulty performing their duties and following instructions. Weapons and other harmful items must be removed from these individuals. In the event of a follow-on chemical attack, patients will need others to help them mask. Protective ensemble must be worn by those assisting the contaminated patient until decontamination is accomplished. The ability to sweat is diminished, making the patient susceptible to heat stress. If the patient's body temperature is greater than 39°C /102°F, they should be moved to the shade and cooled with water or damp cloths. Evacuation to the rear should be considered as early as the situation permits.

Care Provider Actions

BZ casualties may act on their delusions, so they must be kept safe from harming themselves or others. Behavioral symptoms will worsen over the course of a day or more, so patients should be evacuated to a medical facility as soon as feasible. Heat stress is also a real concern. If available, the antidote physostigmine can be given by injection (45 μg/kg in adults; 20 μg/kg in children) or orally, mixed with a flavored drink, if the patient is cooperative. Intravenous administration should be avoided because overdose symptoms, similar to effects of nerve agent exposures, can result if patients are not closely monitored. Primarily given to manage behavior during transport, the antidote must be readministered every hour and titrated to behavior.

Casualty Decontamination

BZ casualties must be decontaminated because dry particles of the agent can remain on outer clothing, on the skin, or in the hair after direct exposure ends. Removal of the outer clothing, accompanied by a water (or soap and water) wash is the best solution. Decontamination with water also helps cool the patient. Decontamination teams must wear protective masks and protective clothing.

Chapter 7

BIOLOGICAL AGENTS

Overview

The course of human history has been greatly affected by naturally occurring diseases. AIDS, influenza, malaria, cholera, tuberculosis, plague, and smallpox have killed hundreds of millions of people and profoundly disrupted or destroyed cultures, societies, and civilizations. Since ancient times humans have tried to harness the destructive potential of biological agents to use against enemies. With the advent of the germ theory of disease and worldwide industrialization, our ability to unleash the destructive potential of biological agents on a large scale has grown considerably.

The threat of biological attacks continues today. Technological advances in chemistry, microbiology, and particularly genetic engineering are making it easier for potential terrorists to develop or acquire novel biological agents or highly infectious "superbugs" that are resistant to antibiotics and vaccines. Compared to other types of weapons, biological agents have relatively low cost and high lethality.

To minimize these threats and conserve the fighting strength, military health care providers must be knowledgeable about biological weapons and the medical management of biological casualties, and ensure that appropriate countermeasures are taken.

Characteristics of Biological Agents

Biological weapons are developed from living organisms and viruses capable of causing disease and death in humans, animals, or plants. Weapons associated with high mortality are referred to as lethal agents, and those that usually produce severe illness, but not death, are referred to as incapacitating agents.

Categories of Biological Agents

The three general categories of biological agents are (1) biological toxins, (2) biological modulators, and (3) pathogens. Biological toxins, or biotoxins, are poisons derived from plants, animals, or microorganisms. Like chemical agents, their onset of action is relatively rapid. Examples include staphylococcal enterotoxin B (SEB), botulinum, and ricin. Biological modulators, or response modifiers, are substances that modify immune responses. They can be both endogenous (produced naturally within the body) and exogenous (eg, pharmaceutical drugs). Some of these substances arouse the body's response to an infection, and others can keep the response from becoming excessive.

Pathogens are microorganisms that cause disease (bacteria, rickettsia, and fungi) and viruses, which, while not living organisms, are replicating agents. Pathogens are the classic agents of biological warfare and the focus of this chapter. Pathogens differ from other biological agents and chemical warfare agents in that they can infect a susceptible host and replicate themselves within it, have an incubation period of days to weeks before clinical signs and symptoms manifest, and in the cases of smallpox and plague, may go on to infect subsequent hosts long after the initial exposure.

Portals of Entry

Biological warfare agents can gain access into susceptible hosts through three portals of entry, depending on how they are weaponized:

1. The respiratory tract is susceptible to aerosols (eg, pneumonic plague).
2. The digestive tract is susceptible to infection from intentionally contaminated food and water (eg, cholera).
3. The skin is susceptible when direct contact with pathogens occurs in non-intact areas damaged by cuts, punctures, or abrasions (eg, cutaneous anthrax).

Psychological Manifestations

Biological agents can produce a patient population of the "worried well": patients who have not been exposed but who may be experiencing fear, anxiety, or panic. Expect numerous indirect casualties from psychogenic illnesses when there is an actual or perceived biowarfare threat. Educating and counseling troops about the threat, instituting appropriate countermeasures, and employing stress control teams early on can significantly reduce combat stress reactions and lessen demand for medical services.

Recognition of a Biological Weapons Attack

Biowarfare uses unconventional weapons, and most methods of dissemination are covert and difficult to identify early on. Outdoors, aerosols are most likely to be sprayed during the hours of limited visibility between dusk and dawn. At night, ultraviolet exposure that can kill the organisms is minimal, and temperature inversions help to keep aerosols near ground level with less dispersion. Indoors, bio-aerosols elude the senses by being essentially odorless, tasteless, and invisible. Agents used to contaminate food and water just prior to consumption are very difficult to detect.

Aerosols can be disseminated by jets, missiles, crop dusters, agricultural sprayers, and modified chemical warfare munitions, such as artillery shells, bomblets, or mines. More covert dissemination techniques by individuals may involve the use of hand-pumped sprayers, aerosol spray cans, modified fire extinguishers, small aerosol generators with timers, and sprayers placed on automobiles or boats to look like exhaust emissions.

Appearance of Weaponized Agents

Unlike many chemical agents, liquid biowarfare agents are non-oily and are typically translucent and slightly more viscous than milk. Unless dyed, bacterial agents in the form of a liquid or powder will likely have a light brown or amber appearance. Only sophisticated production and purification methods will

produce a white bacterial powder. Dried and liquid viral agents can be one of several colors depending on their growth medium: off-white, yellow, brown, or pinkish-red.

Detection

Limited real-time aerosol detection in the field is technically possible with the Biological Integrated Detection System, which a small number of units may have access to (these systems are not widely available because of cost and limitations such as being affected by wind and terrain). For efficient environmental detection, teamwork is necessary. Rapid identification of biowarfare agents is also possible if samples from suspicious ordinance, spraying devices, residues, or powders can be examined. Chemical, biological, radiological, and nuclear reconnaissance teams collect aerosol samples. Preventive medicine personnel collect water samples suspected to be contaminated. Veterinary personnel collect suspect food samples and animal specimens. Medical personnel collect patient specimens. Supporting laboratories evaluate samples for evidence of pathogenic organisms or biotoxins.

Sample Processing

The human respiratory system acts like a suction and filtration system for air, making the nares, cheeks, and hairy portions of the face of people exposed to an aerosol good locations to find the organisms. Taking early postexposure samples with synthetic swabs made out of rayon is preferable, but field expedient sampling with cotton swabs will also work.

Quick tests can be performed in the field to help rule in or out the possibility of a biological exposure. Samples can be tested with litmus paper or a pH meter. If the pH is near neutrality (7.0), viable organisms could be present. The greater the acidity or alkalinity, the less likely it is that any human pathogens will be found. Qualitative ninhydrin tests may show the presence of amino acids. If pH and protein tests are consistent with biological agents, samples may be sent to a lab for further testing. If the sample is unlikely to be a biological agent, it should still be evaluated as a potential chemical agent.

Clothing and equipment are unlikely to reveal significant contamination from an aerosol, but if suspicious powders or liquids are found, place samples of the contaminated material in double zip-locked plastic bags for further testing. All samples should be sent out as soon as the tactical situation permits, and thorough documentation should include person, place, time, and circumstances of possible exposure.

Soon after a biological or chemical attack, consider taking baseline serum samples of all personnel who may have been exposed. Serial serum samples may show changes over time, which helps with the identification of biological and chemical agent exposure. The results may be useful later to epidemiologists evaluating postdeployment syndromes, and assist casualties applying for service-related disability claims.

To take serum samples, draw 20 mL of blood into a tiger-top tube (if these are unavailable, use red-top tubes) and centrifuge for 10 minutes. If clinically indicated, throat swabs, aerobic and anaerobic cultures, sputum, urine, tissue, feces, scrapings, and other specimens should be submitted to a reference lab, where they may undergo various confirmatory tests such as ELISA (enzyme-linked immunosorbent assay), polymerase chain reaction, toxin assays, and microscopic examination.

Epidemiology

Medical intelligence sources may indicate that a biowarfare attack has occurred, prompting a unit to initiate education, vaccination, chemoprophylaxis, treatment, use of protective equipment, or other countermeasures to mitigate risk. In the absence of direct evidence of a biowarfare attack or solid medical intelligence indicating that an attack has occurred, recognition of biological agents must be part of an outbreak investigation seeking a common source of exposure.

The first indication that a biowarfare attack has occurred may be the appearance of a large number of personnel at sick-call presenting with similar signs and symptoms. Soldiers with increased susceptibility, or who were exposed to higher doses of the pathogens, become ill first and act as sentinel cases (or "canaries"). If medics maintain a high index of suspicion, early

diagnosis and treatment may save many lives. Animal illnesses and deaths can also precede human outbreaks and provide clues of a biowarfare attack. Consult with veterinary personnel if signs of suspicious animal deaths and illness occur. Epidemiologic clues of a possible biowarfare attack include the following:

- tight cluster of casualties,
- high infection rate,
- unusual geography,
- apparent aerosol route of infection,
- infection with more than one biowarfare agent,
- unusual clinical presentation,
- unusual munitions,
- animal epizootics,
- sentinel dead animals of multiple species, and
- lower attack rates among the protected.

Syndromic surveillance is the cornerstone of epidemiology. Medics contribute by accurately documenting patient care and disease-and-nonbattle-injury data, and assisting with predeployment and postdeployment health assessments. Many biological agents cause victims to present with nonspecific flu-like signs and symptoms, but some presentations will narrow the differential diagnosis:

- nonspecific symptoms: may indicate tularemia, brucellosis, Q-fever, or viral equine encephalitis (VEE)
- pneumonia: may indicate tularemia, plague, or SEB
- neuromuscular symptoms: may indicate botulism or VEE
- bleeding: may indicate ricin, plague, or viral hemorrhagic fever (VHF)
- dermatologic symptoms: may indicate smallpox, plague, VHF, or T-2 mycotoxin

Responding to a Biological Agent Attack

The immediate response to a suspected biowarfare aerosol should be the same as for a chemical agent exposure. An enemy may deploy chemicals in conjunction with biological agents or use multiple biological agents simultaneously. Mission-oriented

protective posture (MOPP) gear provides excellent protection against all biological agent aerosols. Because the primary routes of entry are through the mouth and nose, masking alone may be sufficient to prevent illness. Effective field expedient respiratory filters can be improvised by breathing through two or more layers of a T-shirt or several layers of tissue paper.

Decontamination

Bio-aerosols with small particles behave like gases and are readily inhaled into the lungs. Fortunately, these aerosolized pathogens are also very unlikely to adhere to people, clothing, or equipment. This reduces the need for extensive decontamination. Larger particles are much less infectious via the inhalation route and quickly fall to the earth, where they are more likely to adhere to surfaces and significantly reduce the risk of re-aerosolization or secondary contamination.

Whether in the air or on the ground, biowarfare agents undergo biological decay from environmental stresses such as ultraviolet light, temperature extremes, and desiccation. Winds of more than 30 mph promote rapid dilution, reducing the agents' effectiveness. With the exception of anthrax spores and the Q-fever agent, most biowarfare agents pose little threat of infection after approximately 24 hours of outdoor environmental exposure. These agents are considered "nonpersistent."

Decontaminate victims of chemical and biological agent exposure quickly and as close to the areas where they were contaminated as possible. Patients must be decontaminated prior to entering a clean treatment area at a medical treatment facility or being medically evacuated.

Field-expedient mass decontamination of biological casualties can be done in uncontaminated lakes and streams, large stationary or small portable swimming pools, and "water buffaloes" (trailer tanks) with hyperchlorinated water. Consider mass showering in fixed facilities, with fire and water trucks or garden hoses. When possible, use hot water if outdoor temperatures are cold.

Soap and water is sufficient for patient decontamination of most biowarfare agents. A 0.5% hypochlorite (bleach) solution is even more effective. Disinfect wounds with betadine or iodine if

available. Sterilize material as indicated with full-strength bleach, steam, boiling water, or dry heat. Thoroughly wash clothing and if possible allow it to be dried and decontaminated by the sun and wind.

Triage and Evacuation

Triage of biological casualties may differ significantly from that of chemical casualties. With chemical agents, expect a large number of casualties presenting at about the same time. With biological agents, the variable incubation period of pathogens and the delayed onset of action of many biotoxins mean that casualties may present over hours, days, or weeks. Therefore, most biological casualties will be triaged as "delayed" or "minimal" (see Chapter 9, Field Management and Triage of Contaminated Casualties on the Integrated Battlefield).

The evacuation category will depend on the patient's current status and prognosis. When calling in a 9-line medevac request during wartime, use brevity code "B" in line 9 for biological contamination. Continue to monitor casualties and change their triage category as needed. Provide reassurance and psychological support while the patient is awaiting further treatment or evacuation to a higher level of medical care.

Major Biological Agent Threats

Inhalational Anthrax (*Bacillus anthracis*)

Anthrax is an acute bacterial infection of the skin, lungs, or gastrointestinal (GI) tract. The primary threat is from an aerosol causing the inhalational (lung) form.

Characteristics. Lethal agent. Aerobic, spore-forming, rod-shaped, gram-positive bacterium. Case fatality rate (CFR) if untreated: 5% cutaneous, 30% GI, and 90% inhalational. Incubation periods are typically 1 to 6 days, with an average of 48 hours. Spores can survive in the environment and remain viable for many years.

Pathogenesis. Aerosolized agent enters the lungs and is engulfed by macrophages, in which spores germinate,

reproduce, and release toxins that cause cellular necrosis, edema, and hemorrhage in the lungs and mediastinal lymph nodes. Frequently spreads to the meninges. Death results from sepsis, hemorrhagic shock, or respiratory failure.

Symptoms. Malaise, fatigue, myalgia, headache, dyspnea, shortness of breath, chest pain.

Signs. Fever, cough, tachypnea, hypotension, meningismus, stridor, diaphoresis, cyanosis. Pathognomic widened mediastinum on chest x-ray secondary to hilar adenopathy and hemorrhagic mediastinitis.

Differential diagnosis. Pneumonia, pneumonic plague, tularemia, gram-negative sepsis, SEB inhalation.

Chemoprophylaxis. Oral ciprofloxacin or doxycycline for known or imminent exposure.

Chemotherapy. Ciprofloxacin 400 mg intravenously (IV) every 12 hours, or doxycycline 200 mg IV loading dose followed by 100 mg IV every 12 hours. Three or four different antibiotics simultaneously will be needed for definitive (hospital) care. Use oral ciprofloxacin, doxycycline, amoxicillin, or penicillin as tolerated if IV medications are not available in the field.

Precautions. Standard precautions only (no person-to-person transmission).

Prevention. Bio Thrax (Emergent Biosolutions, Gaithersburg, MD). Five-shot series given over an 18-month period, followed by yearly boosters. After a known exposure, start the series in unimmunized personnel and give booster shots to personnel who are not current in the series.

Cholera (*Vibrio cholerae*)

Cholera is an acute bacterial infection of the GI tract. The primary biowarfare threat is through sabotage of food and water supplies.

Characteristics. Incapacitating agent. Gram-negative, crescent-shaped, motile rod. Incubation period of 4 hours to 5 days (average, 2 to 3 days). Diarrheal illness usually lasts 3 to 5 days. Most illnesses are subclinical and the CFR is only 1% if casualties are treated appropriately. Without treatment, severe diarrhea can cause death within hours, and the CFR can be as high as 50%.

Pathogenesis. Agent enters the GI tract after consumption of contaminated food or water. Organisms adhere to the intestinal mucosa and secrete an enterotoxin, which elicits a secretory diarrhea that can lead to severe dehydration, electrolyte imbalances, hypovolemic shock, and death.

Symptoms. Painless diarrhea, abdominal discomfort, nausea, malaise, thirst, weakness.

Signs. Profuse "rice-water" stools, emesis, increased (or decreased) bowel sounds, no abdominal pain with palpation, fever, hypotension, dehydration, hypovolemic shock.

Differential diagnosis. *Shigella, Escherichia coli,* salmonellosis, *Campylobacter*, norovirus.

Chemoprophylaxis. Reserve antibiotics for symptomatic personnel.

Chemotherapy. Aggressive rehydration with oral rehydration solution or IV Ringer lactate. Doxycycline 100 mg by mouth twice a day for 3 days. Alternatives: sulfamethoxazole/trimethoprim (TMP-SMX), tetracycline, ciprofloxacin.

Precautions. Enteric precautions (person-to-person transmission unlikely).

Prevention. Secure approved food and water sources from sabotage. Enforce proper field sanitation and hygiene. Cholera vaccines have limited efficacy, and none are currently sold in the United States.

Plague (*Yersinia pestis*)

A bacterial disease known in the Middle Ages as the Black Death, plague has killed hundreds of millions. The primary threat is from an aerosol that causes primary pneumonic plague when inhaled. A secondary threat is from the release of infected fleas that cause bubonic plague, which can spread through the lymphatics and blood stream to cause septicemic plague.

Characteristics. Lethal agent. Bipolar "safety pin" appearance on microscopy. Incubation period 1 to 8 days (average, 2 to 4 days). If untreated, the CFR for bubonic plague is 60%, for pneumonic plague it is over 95% (if treated, the CFR is 50% for both).

Pathogenesis. Aerosolized agent enters the lungs, where virulent antigens can cause a necrotizing pneumonia. Organisms

traveling through the bloodstream can lead to sepsis, spread to the liver, spleen, and central nervous system, and cause further damage. Death results from respiratory failure, circulatory collapse, or internal bleeding.

Flea bites lead to inflamed, hemorrhagic, and extremely painful lymph nodes called "buboes." Organisms travel from the lymphatics to the blood stream, leading to systemic disease.

Symptoms. Fever, chills, malaise, chest pain, swollen and painful lymph nodes (buboes), headache, meningismus.

Signs. High fever, buboes, severe pneumonia, cough, hemoptysis, cyanosis, convulsions, shock, hemorrhagic skin changes and blackening of skin at extremities, disseminated intravascular coagulation (DIC), septic shock. Chest x-ray is variable, but will likely show patchy or consolidated bilateral infiltrates.

Differential diagnosis. Pneumonia, acute respiratory distress syndrome (ARDS), meningitis.

Chemoprophylaxis. Doxycycline 100 mg by mouth twice a day for 7 days. Alternatives: ciprofloxacin, tetracycline (TCN).

Chemotherapy. Streptomycin, IV or intramuscular (IM). Alternatives: 200 mg IV doxycycline once, then 100 IV twice a day for 14 days, gentamicin, ciprofloxacin. If IV/IM medications are not available in the field, use oral medications.

Precautions. Standard precautions for bubonic plague, respiratory droplet precautions for suspected pneumonic plague.

Prevention. No Food and Drug Administration (FDA) vaccine is currently licensed in the United States.

Q-Fever (*Coxiella burnetti*)

Q-fever is an acute and occasionally chronic rickettsial disease that presents as a nonspecific febrile illness or atypical pneumonia. The threat is from an aerosol or the contamination of food.

Characteristics. Incapacitating agents are highly infectious and environmentally persistent rickettsial organisms, with an incubation period of 7 to 41 days (average, 2 to 3 weeks). The acute form is a self-limited febrile illness for 2 to 14 days.

Pathogenesis. Agent enters through the lungs or GI tract, replicates within phagolysosomes, and spreads throughout the

body, eliciting systemic illness and numerous nonspecific signs and symptoms.

Symptoms. Severe headache, chills, myalgia, and fatigue. Less common symptoms are nausea, vomiting, diarrhea, and abdominal and chest pain.

Signs. High fever, dry cough, sweats, and myalgia. Pulmonary embolism of chest is usually normal, but inspiratory rales may be present, and consolidation may be seen on chest x-ray.

Differential diagnosis. Atypical pneumonias, bacterial and viral pneumonias.

Chemoprophylaxis. Doxycycline 100 mg by mouth twice a day for 5 days. Alternative: TCN.

Chemotherapy. Antibiotic therapy should be started 8 to 12 days postexposure if possible. Doxycycline 100 mg by mouth twice a day for 14 to 21 days. Alternatives: TCN, ciprofloxacin, TMP-SMX.

Precautions. Standard precautions. Person-to-person transmission is rare, but secondary aerosols from fomites, such as blankets, can spread the disease.

Prevention. Secure approved food and water sources from sabotage. Enforce proper field sanitation and hygiene. No FDA-approved vaccines are currently available in the United States.

Smallpox (*Variola major*)

Smallpox is a systemic viral illness that killed millions before it was eradicated from nature in 1980. The primary threat is aerosol release of smallpox from covert bio-weapons that may still exist.

Characteristics. Lethal agent, highly contagious virus with a 30% CFR. Incubation period is 7 to 19 days (average, 12 days). Duration of illness is 4 weeks.

Pathogenesis. Aerosolized agent enters the lungs. Replication within cells can lead to an overwhelming viremia, high levels of circulating immune complexes, with illness and death attributed to toxemia.

Symptoms. Malaise, rigors, headache, backache.

Signs. Macular-papular rash that progresses to characteristic vesicular pustules, which become scabs and scars; high fever; vomiting; prostration; delirium.

Differential diagnosis. Chickenpox, monkeypox, allergic contact dermatitis, erythema multiforme with bullae.

Chemoprophylaxis. None.

Chemotherapy. No effective medications exist, treatment is supportive only.

Precautions. Respiratory precautions, strict quarantine of patients and close contacts.

Prevention. ACAM2000 vaccine (Sanofi Pasteur, Swiftwater, PA) is very effective when given prior to exposure. If given after an exposure, but prior to onset of symptoms, the vaccine can prevent or significantly reduce the severity of disease.

Tularemia (*Francisella tularensis*)

Tularemia is bacterial disease with multiple manifestations depending on the portal of entry. The pneumonic and typhoidal forms can occur after an aerosol exposure and have a CFR of 30% to 60% if untreated.

Characteristics. Lethal agent. Highly infectious, gram-negative coccobacillus. Incubation period is 1 to 21 days (average, 3 to 6 days).

Pathogenesis. Agent can enter and infect through all three portals of entry, causing local lymphadenopathy, ulcerations, and a fulminating sepsis leading to death.

Symptoms. Fever, chills, malaise, myalgia, fatigue, respiratory distress.

Signs. Fever, tachycardia, tachypnea, nonproductive cough, mucous membrane lesions, hypotension, prostration, sepsis. Chest x-ray may show effusions, lobar consolidation, cavitation, or hilar adenopathy.

Differential diagnosis. Pneumonia, gram-negative sepsis, mononucleosis, rickettsial diseases, malaria, ARDS.

Chemoprophylaxis. Ciprofloxacin 500 mg by mouth twice a day for 14 days. Alternatives: doxycycline, TCN.

Chemotherapy. Ciprofloxacin 400 mg IV every 12 hours for 10 days. Alternatives: IV/IM doxycycline, TCN, streptomycin, gentamicin. Use oral ciprofloxacin or doxycycline if the IV/IM form is not available in the field.

Precautions. No person-to-person transmission. Standard precautions (minimum infection prevention practices).

Prevention. No FDA-approved vaccine is available in the United States.

Viral Hemorrhagic Fevers

VHFs include a variety of viruses that cause fever and bleeding of varying severity. Examples are Ebola virus; Marburg virus; Hantavirus; dengue; yellow fever; Lassa fever; Rift Valley fever; Crimean-Congo hemorrhagic fever; and Argentinean, Bolivian, Venezuelan, and Korean hemorrhagic fevers. The threat is that these viruses may be weaponized for aerosol dispersal.

Characteristics. Includes lethal and incapacitating agents. Incubation period can be days to months. CFR ranges from less than 10% (hemorrhagic fever with renal syndrome) to 90% (Ebola). Definitive diagnosis is possible only with sophisticated lab tests not readily available in the field.

Pathogenesis. Poorly understood and varies among the viruses.

Symptoms. Fever, myalgia, malaise, fatigue, prostration.

Signs. Fever, conjunctival injection, petechiae, hypotension. Severe illness may have shock, multiple organ system failure, DIC, and death.

Differential diagnosis. Other viral syndromes.

Chemoprophylaxis. Ribavirin 500 mg by mouth four times a day for 7 days, if available; may be somewhat useful for postexposure prophylaxis with some VHF agents.

Chemotherapy. IV ribavirin, if available, may have some efficacy.

Precautions. Contact isolation and possible quarantine. Droplet precautions include mask and eyewear use and thorough disinfection.

Prevention. The only FDA-licensed VHF vaccine is for yellow fever.

Chapter 8

TOXINS

Summary

Signs and Symptoms: Vary among toxins. Botulinum toxins cause descending weakness and paralysis (including respiratory muscle paralysis) along with dry mouth and dilated pupils. Ricin and staphylococcal enterotoxin B (SEB) cause different presentations depending upon the route of exposure.

Detection: No field detectors are commonly available. Detection is mainly through a high index of suspicion and clinical recognition of signs and symptoms.

Decontamination: Clothing removal and skin cleansing using water (with or without soap) is generally sufficient.

Management: For almost all toxins, treatment is supportive only. This includes the potential necessity of ventilatory support for weeks following exposure to botulinum toxins, although a botulinum toxoid product is effective if given before signs and symptoms appear. Active immunization with botulinum toxoid is available only as a preexposure measure for those at demonstrated high risk.

Classification and Mechanisms of Action

The term "toxin" is sometimes used as a general synonym for poison; however, it is more strictly defined as a poisonous substance produced by a living organism. Unlike biological organisms, toxins do not replicate inside hosts or cause infection; rather, they produce "intoxication" or poisoning. Victims of toxins are not contagious.

There are hundreds of biological toxins, but most have not been developed for use as mass-casualty weapons. Toxins can be grouped according to source as bacterial, algal, fungal, plant, marine dinoflagellate, marine soft coral, arthropod, molluscan, or vertebrate. Additionally, they can be divided by mechanism of action into neurotoxins (toxins that affect neurotransmission), cell-damaging toxins, and superantigen toxins (which nonspecifically activate the immune system).

Detection

Laboratory detection of toxins in the environment or in biological samples is not generally available in the field. Detection will rest primarily upon a high index of suspicion and clinical recognition of signs and symptoms.

Physical Properties and Protection

Toxins can be dissolved in various other substances or spread as aerosols and may not be visible or irritating; exposure can occur without the knowledge of the victim. Aerosolized toxin can be inhaled or can settle on the skin, although only the T-2 mycotoxins are dermally active. Toxin can also be ingested or injected. Protection against inhalation and skin contact is provided by the protective mask and by any clothing that covers the skin.

Decontamination

Removal and laundering of clothing and skin cleansing using water (with or without soap) is all that is usually necessary. Because toxins are poisons rather than living organisms, disinfection and sterilization are not applicable.

Specific Toxins

- **Botulinum toxins**, a group of seven related neurotoxins produced by the bacterium *Clostridium botulinum*, are the most potent known poisons and cause botulism through ingestion

or toxin production in wounds. Victims exhibit descending skeletal muscle weakness (beginning with blurred vision, inability to fully open the eyelids, and difficulty swallowing) within 12 to 36 hours after inhalation of aerosol or up to several days after ingestion. The pupils dilate and the mouth is dry. Eventually, respiratory paralysis leads to death, unless ventilatory support can be established and maintained for several weeks. Intravascular and intramuscular administration of botulinum antitoxin is effective during the latent period, but rapidly becomes ineffective after signs and symptoms begin to appear. A toxoid is available for vaccinating laboratory workers at known risk of exposure.

- **Ricin** is a cell-damaging toxin extracted from the castor bean plant (*Ricin communis*). Ricin has been injected into victims in covert assassination attempts. The toxin binds to ribosomes and impairs protein synthesis. Ingestion produces mainly gastrointestinal effects; inhalation causes damage to both the central and peripheral compartments of the respiratory tract (leading to airway necrosis and pulmonary edema); and injection generally spares the respiratory tract, but leads to widespread organ necrosis and disseminated intravascular coagulation. No antitoxin (for passive immunization after exposure) or toxoid (to produce active immunization prior to exposure) is available for humans. Treatment is supportive.
- **SEB** is a superantigen toxin that causes self-limited incapacitating (seldom lethal), abrupt-onset abdominal pain, vomiting, and diarrhea after ingestion. Difficulty breathing, nonproductive coughing, fever, chills, and headache appear 3 to 12 hours after inhalation of aerosolized toxin. Treatment is supportive.
- **T-2 toxin** is one of the trichothecene mycotoxins (produced by fungi). Within 10 to 30 minutes after inhalation or ingestion, it can cause bloody vomiting and diarrhea, chest pain, and dizziness. Skin blisters can appear after skin contact. Death can follow weeks later from bone-marrow suppression, liver failure, or internal bleeding. Treatment is supportive.
- **Aflatoxins** are fungal toxins that are acutely toxic as well as being immunosuppressive, mutagenic, and carcinogenic. Acute effects include abdominal distress, pulmonary edema, and convulsions. Treatment is supportive.

- **Abrin** is a cell-damaging toxin found in jequirity beans. It is similar to ricin, but in mice is 75 times more toxic. Treatment is supportive.
- **Domoic acid** is an excitatory neurotoxin responsible for amnesic shellfish poisoning, which can cause seizures. Treatment is supportive.
- **Epsilon toxin** (from *Clostridium perfringens*) is a cell-damaging toxin. Ingestion increases the permeability of the small intestine and leads to increased absorption and damage to blood vessels, especially in the kidney, liver, and brain. Inhalation can cause damage to pulmonary vessels. The toxin is dermally active and can cause skin lesions. Treatment is supportive.
- **Epibatidine** (produced in the skin of poisonous frogs) and anatoxin-a (from cyanobacterial, or blue-green algae) produce the nicotinic effects of nerve agents; anatoxin-a(s), another cyanobacterial toxin, produces both the nicotinic and the muscarinic effects of nerve agents. Treatment is the same as for nerve agent poisoning.
- **Saxitoxins** are cyanobacterial (blue-green algal) toxins that cause paralytic shellfish poisoning. They can cause death within 10 seconds via paralysis. Treatment is supportive.
- **Tetrodotoxin** is an inhaled or ingested marine neurotoxin found in certain saltwater fish (such as puffer fish), crabs, starfish, blue-ringed octopi, newts, and salamanders. Death occurs from paralysis. Treatment is supportive.
- **Palytoxin** is a cyanobacterial (blue-green algal) toxin concentrated in corals. It is nearly as potent as botulinum toxins and causes vascular collapse and cardiotoxicity. Intracardiac injection of vasodilators may be the only recourse.

Chapter 9

FIELD MANAGEMENT AND TRIAGE OF CONTAMINATED CASUALTIES ON THE INTEGRATED BATTLEFIELD

Preparedness

Providing timely and proper casualty management on the contaminated battlefield must begin with preparations long before deployment. Individual unit members must be trained to correctly identify chemical agent exposure based on signs or symptoms and to correctly perform self-aid, buddy aid, and decontamination. All care providers must be thoroughly trained and prepared to carry out the following elements of casualty management:

- Correct identification of chemical agents based on observed signs or symptoms experienced by the casualty.
- Complete understanding of the severity of exposure based on signs and symptoms.
- Correct identification of routes of entry of the agent and method of exposure (from liquid and/or vapor) based on signs and symptoms.
- Proper triage of chemical casualties or mixed conventionally wounded and chemically contaminated in mass casualty situations.
- Correct treatment of casualties in response to symptoms, proper use of antidotes, and other supportive care that may be required during or after initial treatment (eg, assisted ventilation or airway suction).

- Complete understanding of the various casualty types that can be encountered on the contaminated battlefield.
- Complete understanding of ambulatory and litter casualty decontamination operations at the medical treatment facility (MTF).
- Identification of personnel limitations and equipment shortfalls in support of casualty decontamination and treatment.
- Understanding of the impact of contaminated and decontaminated casualties on evacuation operations.

Once in the field, the care provider must be aware of additional elements that impact contaminated casualty management operations, including the following:

- Current enemy chemical capabilities including means of deployment (eg, artillery, rockets, or spray), and their anticipated use.
- Tactical intelligence gathered after any verified enemy use of chemical agents.
- Current protective posture of the unit and how vigorously it is maintained.
- Current status of unit and individual chemical defense readiness.
- Morale of unit members and their confidence both in the unit and in each other.
- Complete understanding of current and near-term combat operations.

All of these elements, when considered together, allow the care provider to take a proactive readiness posture for casualty management operations on the contaminated battlefield. The rest of the chapter will expand on these elements.

Training

Medical personnel and nonmedical augmentees who are involved in the casualty decontamination effort must be trained and show proficiency in the following tasks:

- Drink from a canteen while wearing the protective mask.
- Recognize signs or symptoms of heat injury.
- Identify liquid chemical agents using M8 Chemical Detector Paper.
- Detect chemical agents using M9 Chemical Agent Detector Paper.
- Evaluate a casualty.
- Prepare decontamination solutions for patient decontamination operations.
- Recognize signs and symptoms of chemical exposure.
- Administer nerve agent antidote to self (self-aid).
- Administer nerve agent antidote and CANA (Convulsive Antidote, Nerve Agent) to buddy (buddy aid).
- Transport litter casualties using both two-person and four-person litter carries.
- Conduct casualty litter exchange using the log-roll method.
- Remove litter casualty's contaminated clothing.
- Perform skin decontamination on litter casualties.
- Operate the Improved Chemical Agent Monitor (ICAM).
- Perform wound or injury management during litter and ambulatory patient decontamination.
- Remove ambulatory casualty's contaminated clothing.
- Monitor patients for residual contamination after completion of decontamination process.
- Prepare the M22 Automatic Chemical Agent Detection Alarm (ACADA) or Joint Chemical Agent Detector (JCAD) for operation.
- Operate the M22 ACADA or JCAD to monitor the clean treatment area and the MTF.
- Operate the M256A1 Chemical Agent Detector Kit.
- Conduct unmasking procedures using the M256A1 Chemical Agent Detector Kit.
- Decontaminate open wounds.
- Describe and perform emergency medical treatment required to stabilize a casualty for decontamination.
- Identify triage requirements based on signs or symptoms.
- Transcribe the patient field medical card at the hot line and shuffle pit.
- Perform collective protection shelter exit and entrance procedures.

- Perform mission-oriented protective posture (MOPP) gear exchange.

NOTE: *This list is a suggested training guide to support thorough patient decontamination operations. The list has a variety of tasks including some that are specifically medical. All staff at a patient decontamination station should be familiar with all individual and collective tasks associated with patient decontamination operations.*

Exposure History

Once an incident occurs, the care provider must determine the exposure history. The care provider will encounter seven general categories of casualties on the contaminated battlefield:

1. exposed and contaminated;
2. exposed and not contaminated;
3. conventionally wounded, exposed, and contaminated;
4. conventionally wounded, exposed, and not contaminated;
5. conventionally wounded, not exposed, and contaminated;
6. conventionally wounded, not exposed, and not contaminated; and
7. psychological (worried well).

The care provider must be aware of the various factors influencing production of these types of casualty. Understanding the circumstances that produced the casualty will help the care provider in the casualty's triage, treatment, and evacuation. Questions to ask about these factors are as follows:

1. What was the unit's protective posture at the time of exposure?
2. Was the encounter a result of movement through chemical contamination or a result of direct attack on the unit?
3. Was a movement through the chemical contamination deliberate or unintentional?
4. Was the unit in contact with enemy forces at the time of the encounter?
5. Did the unit encounter chemical agents in vapor form only, liquid form, or a combination of both?
6. Has the unit's chemical survey team verified the agent?

An important informational link between exposure and treatment at the MTF is the history surrounding the exposure, the soldier's activities since the exposure, and the progression of symptoms. The following questions will be helpful:

At Time of Exposure

- Did the M9 Chemical Detector Paper react?
- Was the agent verified in liquid or vapor or a combination of both?
- How was the agent identified and verified?
- What decontamination actions occurred and when did they occur in relation to the time of detection (eg, skin decontamination, eye flushing)?
- What level of MOPP was the casualty wearing at the time of exposure?
- If MOPP was not used, did the casualty don individual protective equipment over his or her exposed battle uniform?
- What was the unit's exposure time in the contaminated environment?

After Onset of Symptoms

- Were Antidote Treatment Nerve Agent Autoinjector (ATNAAs) or CANA (diazepam) used, and if so, when in relation to the onset of symptoms?
- Has the soldier been taking the nerve agent pretreatment pill? How many, and when was the last one taken?
- What symptoms has the casualty experienced?
- How long since the last onset of symptoms?
- What activities has the individual engaged in since the initial exposure?
- What was the casualty doing when the symptoms began?
- What level of MOPP was the casualty in when symptoms began?

Knowing the soldier's protective posture at the time of exposure, the time taken to react to the exposure, and the actions taken by the soldier in response to the exposure will assist the triage effort and subsequent treatment effort at the MTF. Obtaining as

complete a history as possible, coupled with unit chemical survey data, will enhance these efforts. Providing too much information on the field medical card is far better than not providing enough.

Casualty Evaluation

The proper management of casualties must begin with an in-depth understanding of the various types of casualties and the specific treatment requirements of each. When the care provider is confronted with one or more casualties on the contaminated battlefield, a deliberate decision-making process must begin. Taking deliberate steps to evaluate the casualty, regardless of condition, will allow him or her to be triaged into the correct category. This, in turn, will optimize the casualty's care and chance of eventual return to duty.

At times, the medic will need to decide which course of action to follow. The deciding factor will always be to treat the condition that poses the most immediate threat to life, limb and eyesight. The most critical step of the decision-making process is triage.

Triage is defined as the classification of casualties according to type and seriousness of injury. Effective triage allows orderly, timely, and efficient use of medical resources. Triage is necessary during a mass casualty situation or when the casualty load overwhelms medical resources, and there is a need to sort and prioritize casualties for care. When the number of casualties does not overwhelm medical resources, triage is not necessary.

During a mass casualty situation, the goal is to provide the best care for the most casualties, without wasting time or resources. Ideally, care would be provided first to those who are in immediate danger of dying because of their wounds and have the best chance of survival. Triage means assigning medical priority for treatment to the casualty, not assigning priority for decontamination.

Surveying the Chemical Casualty

Chemical casualties may have conventional wounds in addition to agent exposure, and standard guidelines for the initial survey of a casualty must also be followed. These guidelines should be discussed with the unit's medical officer and modified accordingly. Guidelines for surveying a chemical casualty, performed prior to triage, are provided below.

- Look for any field medical card that was initiated.
- Look for empty antidote autoinjectors attached to overgarment.
- Question the casualty's buddy regarding the following:
  - type of agent and how it was identified,
  - initial signs and symptoms,
  - conventional wounds noted,
  - buddy aid rendered,
  - any other prior treatment for suspected chemical exposure and conventional wounds, and
  - use of nerve agent pretreatment drug (pyridostigmine).
- Observe the casualty's protective clothing and equipment for signs of liquid chemical contamination.
- Survey casualty for conventional injuries.
- Survey casualty for continued signs and symptoms of chemical agent poisoning.
- Determine whether or not the casualty can respond to a command:
  - ask the casualty to describe signs and symptoms, and
  - observe whether or not the casualty responds in an orderly fashion when following simple directions. Suspect shock or central nervous system involvement if he or she cannot respond properly.
- Observe the casualty for the following symptoms:
  - sweating through the overgarment or on exposed skin (indicating a skin exposure to liquid nerve agent),
  - labored breathing,
  - coughing, or
  - vomiting.
- Check the casualty's pulse by placing your fingers on the carotid artery. This may be done through the hood; however, if no aerosolized agent remains in the air, don the tactile chemical protective gloves, decontaminate both the gloves and the skin on the neck, and reach under the hood and feel for the pulse on bare skin.
- Check for pupil reactivity by covering the eye lens with gloved hands, then uncovering them and observing for pupil reaction.

When this survey is completed, begin triage.

Triage Categories

Triage categories are immediate, delayed, minimal, and expectant. In chemical, biological, radiological, or nuclear (CBRN) mass casualty situations, the magnitude of the casualty situation necessitates that the conventional treatment priorities be modified. This means a radical departure from the traditional practice of providing early complete essential treatment to each casualty on the basis of individual needs. In these mass casualty situations, using priorities designed to provide the greatest benefit for the largest number of patients without wasting specialist skill and medical resources, the following system of triage is used.

Immediate

This category includes those requiring emergency lifesaving or limb-saving surgery. These procedures should not be time consuming and should involve only those casualties with high chances of survival (eg, cases of respiratory obstruction, accessible hemorrhage, and emergency amputation). Examples of immediate casualties are provided below.

- Casualties who are not displaying signs and symptoms of chemical agent exposure but have a life-threatening conventional injury (eg, gross external bleeding, sucking chest wound, flail chest, airway obstruction, or tension pneumothorax).
- Severe nerve agent casualties with or without conventional wounds, including those who have labored breathing, those who recently stopped breathing but still have adequate circulation (a good blood pressure), and those who are convulsing or have convulsed.
- Casualties of cyanide poisoning who are gasping or have just stopped breathing but still have adequate circulation.
- Casualties in respiratory distress from phosgene, a phosgene-like substance, or a vesicant. The care required for these casualties exceeds that available at forward care facilities. These patients should be triaged as immediate only if they can be quickly evacuated to a Role 3 or higher MTF for intensive care.

Delayed

This category includes those who need time-consuming major surgery or resuscitation, but whose general condition permits delay in treatment without unduly endangering life (eg, large muscle wounds; fractures of major bones; intraabdominal, thoracic, head, or spinal injuries; uncomplicated major burns; and some incapacitating effects of CBRN agents). To mitigate the effects of delays in surgery or other treatment, sustaining treatment such as stabilizing intravenous fluids, splinting, administering antibiotics, catheterizations, gastric decompression, pain relief, and pharmacological and respiratory support for the effects of CBRN agents is required.

Minimal

This category includes those with relatively minor injuries who can effectively care for themselves or who can be helped by untrained personnel (eg, minor lacerations, abrasions, fractures of small bones, minor burns, and nonincapacitating effects of CBRN agents). Examples are as follows:

- Casualties with moderate to mild nerve agent poisoning who have taken the antidote, are recovering, and are not in distress.
- Casualties who have minor conventional wounds.
- Blister agent casualties with a small amount of erythema or a few small blisters in noncritical areas.

Expectant

This category includes casualties who have received serious and often multiple injuries, whose treatment would be time-consuming and complicated, and who have a low chance of survival (eg, severe multiple injuries, severe head or spinal injuries, large doses of radiation, widespread severe burns, and intractable central nervous system or respiratory effects of CBRN agents). If fully treated, these casualties make heavy demands on medical personnel and supplies. Until the mass casualty situation is under control, these patients should receive supportive care according to available staffing and resources. Continued efforts

to ensure their comfort by use of appropriate doses of narcotic analgesics and to retriage as more resources become available are vital to managing these patients. These casualties should not be abandoned, and every effort should be devoted to their comfort.

Moving Casualties Through the Patient Decontamination Site

Casualties are moved through the decontamination site based on priorities for treatment.

- **Immediate** casualties are transferred to the warm side emergency medical treatment area for stabilization. After stabilization, these casualties are taken to the litter patient decontamination area.
- **Delayed** casualties may require treatment in the clean treatment area before evacuation. If they need treatment, they are sent to the ambulatory or litter decontamination line. If they do not need treatment in this area, they are sent directly to the evacuation holding area.
- **Minimal** casualties may receive treatment in the clean treatment area or the contaminated emergency treatment area. If they can be treated in the contaminated emergency treatment area and they have no break in their chemical protective overgarment, they will return to duty from this area. If they require treatment in the clean treatment area, they will be sent to one of the decontamination areas before entry into the clean treatment area.
- **Expectant** casualties will be transferred to designated contaminated holding areas.

Chapter 10

PATIENT DECONTAMINATION STATION: PLANNING, SETUP, AND OPERATION

This chapter is adapted from: US Army, Marine Corps, Navy, Air Force. *Multiservice Tactics, Techniques, and Procedures for Health Service Support in a Chemical, Biological, Radiological, and Nuclear Environment*. Washington, DC: Department of Defense; 2009. FM 4-02.7.

Overview

Patient decontamination is a labor-intensive undertaking and requires augmentation personnel, additional or specialized equipment, and training for all personnel involved. Proactive planning will minimize the impact on the affected unit and help ensure that the overall medical mission is not impaired. With training, thorough planning, and aggressive execution, an effective patient decontamination procedure can be established.

The care of contaminated casualties, although more complicated than that of conventional casualties, must not stop the ongoing medical mission. Medical officers and noncommissioned officers (NCOs) must develop realistic, battle-focused plans. They must then refine and validate these plans in challenging training exercises to ensure the success of health service support on the future battlefield.

There are three levels of patient decontamination:

1. **Immediate decontamination**. Primarily performed to protect the individual. The contaminated person removes contamination from his or her individual protective ensemble (IPE), equipment, and skin as quickly as possible after exposure. Another individual (buddy) provides immediate decontamination for casualties who are unable to do it themselves.
2. **Patient operational decontamination**. Performed to protect operators of transport vehicles. Unit members remove as much contamination as possible from the casualty's IPE, equipment, and skin without removing the IPE. This is done to prepare the individual for transport on designated "dirty" (contaminated) evacuation assets to the next role of medical care.
3. **Patient thorough decontamination**. Operators of the patient decontamination station (PDS) perform this procedure to protect medical facility staff and equipment and to reduce patient contamination. It involves removal of contaminated IPE and a thorough decontamination of any contaminated skin before a patient enters a medical treatment facility (MTF).

NOTE: *It is possible that patients triaged as minimal or delayed never go through patient thorough decontamination at the battalion aid station or other far forward MTF. Instead, they may be treated in the dirty treatment area and returned to their unit. Other patients with more severe conditions, once stabilized, may have their IPE decontaminated but not removed. These casualties are then taken to the next role of care (dirty evacuation) without going inside the battalion aid station. At the larger MTF, they will undergo patient thorough decontamination before admission into the facility.*

Historically, the most difficult aspect of care for contaminated casualties has been the actual decontamination effort. The material presented in this chapter is derived from recently conducted tests, doctrinal procedures, and the practical experiences of medical NCOs and those trained in CBRN response. It will provide suggestions on how to successfully conduct contaminated casualty decontamination. Each role of medical care must have an operational PDS function.

Key Planning Elements

The in-depth planning required for operating the decontamination site must include the anticipated casualty load, day or night operations, weather conditions, work and rest rates for personnel, logistical support for the site, and the acceptable impact on ongoing conventional medical operations. Key elements that must be considered in the planning process include:

- the unit's mission
- wind direction
- security of decontamination site
- access control to decontamination site
- number of casualties to be treated
- equipment sets and supplies
- personnel requirements
- work/rest cycle considerations
- establishing a patient decontamination station
- disestablishing a patient decontamination station
- litter casualty decontamination procedures
- ambulatory casualty decontamination procedures
- dirty evacuation assets

The Battlefield

A picture of the battlefield subjected to a chemical or biological attack (where contaminated casualties originate) is required if planning is to anticipate, with some degree of accuracy, the appropriate level of preparation required for casualty decontamination and care. Chemical agents can be introduced into the environment as a solid, liquid, or gas (or aerosol), depending on the weapon system used. Biological agents can be introduced into the environment in wet or dry form. Examples are:

- aerosols,
- slurry mix (wet),
- large, thick drops,
- dry powder,
- spores, or
- vectors.

Regardless of which form a chemical or biological agent is in when introduced, these weapons will contaminate personnel, terrain, and equipment on the ground. However, it is not enough to know that contamination occurred; it is also necessary to discuss the extent of the contamination and how long it will last. The following section covers military CBRN attacks resulting from the offensive use of CBRN weapons.

Chemical Contamination

This section is adapted from: US Army, Marine Corps, Navy, Air Force. *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Contamination Avoidance*. Washington, DC: Department of Defense; 2006. FM 3-11.3. Specifically:

- Appendix D, Weather Effects on Nuclear, Biological, and Chemical Agents and Meteorological Reports, covers the method for predicting the area affected by a chemical attack;
- Appendix E, Chemical-Contamination Avoidance Tactics, Techniques, and Procedures describes the prediction report (NBC3 CHEM);
- Appendix F, Biological Contamination Avoidance Tactics, Techniques, and Procedures covers predictions for biological attacks; and
- Appendix H, Release-Other-Than-Attack Contamination Avoidance Tactics, Techniques, and Procedures describes hazard prediction resulting from toxic industrial chemicals.

The most common misconception people have about chemical contamination is that vast areas of the battlefield will be contaminated by liquid chemical agents. Another misconception is that everything in the contaminated area will be "dripping" with chemical agents. Instead, contamination assessments should be done according to the method described below.

The NBC3 CHEM report is a prediction of the hazard area. This prediction is safe-sided to ensure that a significant hazard will not exist outside the predicted hazard area. A chemical contamination prediction should include two important aspects

of the chemical attack: (1) the attack area, in which liquid contamination can be found, and (2) the hazard area, which is the area downwind from the attack that can be affected by chemical vapors originating in the attack area. The prediction includes a determination of whether the attack was an air-contaminating attack, which is with nonpersistent agents (type A) and has little or no liquid contamination on the ground; a ground-contaminating attack, with persistent agents (type B); or an attack of unknown origin (type C).

The dimensions of the attack area are based on the type of agent employed and weapon system used. The attack area will be larger than the actual area contaminated by a liquid chemical agent. In a liquid or aerosol attack, the type B attack area is predicted to be shaped like a cylinder. Although it can be several kilometers in length, it will be no more than 2 km wide at any point. This type of attack will contaminate the greatest area of all the attack types shown.

Contaminated casualties can cause cross-contamination, posing the greatest risk during initial medical treatment and patient decontamination because of the potential liquid contamination that may be transferred to the care provider, to the interior of evacuation vehicles, or to non-medical augmentees performing patient decontamination. These casualties can pose both liquid and vapor hazards, from liquid on their clothing and equipment, from evaporating liquid agent, and from vapors trapped in clothing fabric and hair. Because of these liquid and vapor risks, it is important to understand as much as possible about the attack and hazard areas.

Exposure to a vapor poses less of a hazard to decontamination operators than exposure to liquid agent or concentrated aerosols. Often vapor exposures, predominant in a type A attack, will quickly volatilize (evaporate) before the patient reaches the decontamination station. In these cases, removing the clothing and briskly rubbing or washing the hair (if the hair was exposed and unprotected by IPE) may be all that is needed to release the trapped vapors.

Type A Attack. The type A attack occurs when enemy forces believe that a large concentration of chemical agent vapors will surprise US forces and cause casualties through inhalation. This

attack usually is conducted by firing large numbers of highly volatile (nonpersistent) chemical agent munitions into a relatively small area. These nonpersistent agents are nerve (GB, GD), pulmonary (CG), vesicating (CX), and cyanide (AC, CK) agents.

A type A attack will not normally be aimed directly at a unit's position but will occur "off-target," that is, at some distance away from the unit, to maximize the development of a vapor cloud and the number of casualties. This will be particularly true of an attack that uses the G-series nerve agents, the pulmonary agent CG, or the vesicating agent CX. If a cyanide agent is used, the attack will most likely be in or extremely close to a unit's location because of the rapid expansion of cyanide vapor in the air and its ability to mix easily with the surrounding air, causing rapid dilution. Cyanide is most effective in enclosed spaces such as buildings.

Casualties in the type B attack area present potential liquid and off-gassing vapor hazards, whereas casualties in the type A hazard area pose only an off-gassing hazard. However, in most cases, any liquid chemical agent found on type A attack casualties will be minimal because of the rapid evaporation of the highly volatile liquid chemical agents from the IPE's outer material. Although the M9 Chemical Agent Detector Paper (tape) worn by casualties in the attack area will show a positive color reaction upon exposure to any liquid chemical agents, detecting and identifying the agent may be difficult using M8 Chemical Agent Detector Paper during triage at the decontamination site because of evaporation. The Improved Chemical Agent Monitor (ICAM) may be useful here.

Type B Attack. A type B attack occurs when enemy forces believe that terrain denial or the creation of a chemical barrier will slow US forces or cause them to maneuver around the obstacle, potentially into a preplanned killing zone. Type B attacks are likely to be placed on or near units to maximize the effect of liquid and heavy vapor contamination on personnel and equipment. The type B attack area can be several times larger than the type A area. The use of a type B attack on choke points (ie, narrow points in a valley, road junctions, or crossing points at water obstacles) can be expected, especially if US forces are in these locations.

Type B attacks use persistent chemical agents, which have a low volatility, taking more than 24 hours to fully evaporate. The persistent chemical agents are nerve (thickened GD, VX)

and vesicating (L, H, HD) agents. Type B attacks represent the worst case scenario for medical support because of the long-term hazard posed by liquid chemical agents. Until deliberate chemical surveys indicate a type A attack has occurred, the response is planned according to a type B scenario.

Casualties caught in the open without overhead cover during a type B attack will have easily visible oily splashes or a large number of oily spots of varying sizes on their IPE. The mask carrier and load-bearing equipment will also have spots or smears that cannot be a result of perspiration. The M9 detection tape may also have positive indications of chemical agent drops (some as small as 100 μm) and a few streaks. After the actual attack has stopped, the individual will probably contact objects such as plants or equipment that have agent on them. This can smear agent on IPE and protective gloves, causing oily smears or spots of varying sizes. The M9 detection tape will have more streaks than spots, which could indicate that the casualty brushed against the liquid while moving. Casualties in the hazard area of the type B attack will pose the same hazard as a type A casualty, that is, off-gassing vapors from the IPE.

Type C Attack. In a type C attack, the origin of the attack is unknown. These attacks will most likely be found by a survey or reconnaissance. A 10-km radius is drawn around the center of the detection location, and the area within the circle represents the attack area and the hazard area. Casualties in this area will most likely pose the same hazard as type B attack casualties.

Biological Contamination

Unlike the extensive information available on chemical contamination, knowledge about the incubation period of biological agents is limited. US forces may not know that a biological attack has occurred, or even which biological agent was used, until several days to a week after the attack has actually occurred. Once a biological attack is suspected, the prediction method in FM 3-11.3, Appendix F, will be used to assess what terrain was potentially contaminated, which units were present

in the predicted area of contamination, and how long these units remained in the affected area. A medical response will then be planned that is appropriate for the agent used and the anticipated casualty load.

Biological attacks can be categorized into four groups, based on the means of delivery and wind speed: type P attacks, using localized exploding munitions such as bombs, shells, rockets, mines, missiles, and surface release sprays; type Q attacks, using munitions that cover a large area such as bomblets or air burst missiles; type R attacks, in which the location of the attack is known, but the type is unknown or the attack was from an air release spray or generator; and type S attacks, in which detection occurs after an unobserved attack.

Biological agent casualties can occur in a larger area than in a chemical attack. As the cloud of agent travels farther downrange, it is exposed to the environmental elements and subjected to dispersal, settling, and impaction on features of the terrain. During this process the cloud loses much of its concentration, and subsequently most of the unprotected personnel exposed will not receive an infective (pathogen) or effective (toxin) dose. As a result, dispersal will not be uniform, and casualties may occur as far as four to five times the maximum downwind hazard distance (DHD) of chemical agents when environmental conditions are optimal for dispersal.

The size of the attack area and the maximum DHD vary greatly depending on the type of biological agent attack. Knowing the type of attack will allow medical unit leaders to better allocate their resources. The maximum DHD for each type of attack must be calculated using the chemical downwind message. Information for calculating the maximum DHD is described in FM 3-11.3, Appendix F.

Depending on the type of biological attack, the total DHD may produce a hazard area of enormous proportions. Any casualty from a location within the attack or hazard area who requires medical support must be considered contaminated and handled appropriately. This standard response should continue until deliberate biological sampling has taken place and the laboratory analysis of the samples indicates that a biological threat no longer exists.

NOTE: *Biological casualties who arrive at the MTF with flu-like symptoms and have bathed in the last day or two have already decontaminated themselves. Most biological agents do not remain active on clothing for more than a day or two and are killed by heat or sunlight exposure. The exception is anthrax spores, which remain a hazard for months to years and can be trapped in clothing fibers and hair if clothing has not been changed or hair washed since the attack.*

Tactical Planning

When a chemical or biological attack occurs on or near a unit, the supporting medical platoon must be prepared to quickly and efficiently transition from conventional casualty operations to contaminated casualty operations. To accomplish this transition, the medical platoon leader or sergeant must be alerted almost as quickly as the unit commander that an attack has occurred. For this information to be obtained as soon as possible, one of these individuals must be located in the unit tactical operations center. When an attack occurs, an NBC1 observer's report will be sent or automatically generated through the Chemical, Biological, Radiological, and Nuclear Warning and Reporting System, which will alert the unit that a chemical attack has occurred (see FM 3-11.3). Because the unit CBRN NCO or officer will lack vital chemical/biological survey information during the first hour or so after an attack has occurred, it must be assumed that, in the case of a chemical attack, a type B attack has occurred (as discussed above).

The medical response must begin with a quick evaluation of the attack, including factors that may indicate the type of casualties most likely to be seen, and the type of contamination these casualties will bring in with them—liquid versus vapor, chemical versus biological. This evaluation will be based on the following information:

- The location of all units supported by the medical platoon.
- The location of the attack (line F of the NBC1 report).
- Release information on agent attacks (line I of the NBC1 report). If line I is unknown, then assume a type B attack.

- Which units were in the attack area.
- Which units were in the hazard area.
- The readiness posture of any unit inside the predicted attack and hazard areas.
- What mission-oriented protective posture (MOPP) level the affected unit was in.
- What type of terrain the unit occupied. (Built-up, urban terrain could indicate that overhead cover was available to shield personnel against the initial liquid contamination. Wooded terrain could also indicate some overhead cover provided by the forest canopy. Desert terrain indicates very little overhead cover.)
- How long the unit had been in its position.
- If nerve agent is suspected, whether the unit took pyridostigmine pretreatment (although this will not alter treatment).
- If nerve agent is reported, how the agent was verified. (The Joint Chemical Agent Detector [JCAD], M22 Automatic Chemical Agent Detection Alarm [ACADA], and M256A1 Chemical Agent Detector Kit indicate a vapor or aerosol hazard only; M9 tape indicates an aerosol or liquid hazard; M8 detector paper indicates a liquid hazard only. Any combination of M8 detector paper, the M22 ACADA or JCAD, and M256A1 detector sampler indicates both a liquid and vapor hazard.)
- Whether the attack consisted of a chemical attack only, or also included conventional high explosive munitions used alone or along with a ground attack.
- Whether any suspicious liquid failed to cause a reaction on M9 or M8 paper.
- If aerosols were observed being disseminated, and whether a stand-off automatic chemical agent detector alarm or any other chemical detection devices failed to indicate a chemical agent.
- Whether a biological attack was suspected, and with what indicators.
- Whether any biological agent rapid detection field tests indicated a possible biological agent.

Establishing the Decontamination Site

The ability of the medical platoon or, more specifically, the treatment squad to establish the decontamination site will depend greatly on unit support. Long before the medical platoon deploys, the unit leadership must understand the need for manpower and equipment support. Additionally, when possible, the commander should predesignate in the tactical standard operating procedures which sections of the headquarters unit will provide personnel or equipment to the medical decontamination site. The medical platoon leader should ensure that the sections tasked to provide personnel are trained prior to deployment and that after deployment they receive quick refresher training when possible.

When an attack occurs, the required personnel and equipment must be available almost immediately. The medical platoon leader or platoon sergeant must maintain a current status of required support equipment and a continuously updated roster (by name) to ensure personnel and equipment can be quickly assembled when a timely response is critical to patient care.

Wind Direction

Wind direction and speed are critical factors in planning because of the vapor hazard that will be present downwind from the PDS. When planning for patient decontamination, the assumption must be made that, after decontamination operations begin, chemical agents in vapor and liquid form will be present in areas of the PDS (open dirty dump, patient arrival and triage area, etc). Consideration must be given to the effect that wind-driven chemical agent vapors have on other unit operations or on other co-located units. A valid concern of unit commanders will be the uncontrolled effect vapors have. This factor may be a reason to plan for decontamination outside the unit area.

Knowing the anticipated wind direction and wind speed, and their estimated duration, will allow for a swift response to incoming chemical casualties. The decontamination site will therefore initially be set up to take advantage of the prevailing

wind, with the "clean" (uncontaminated) area operations always being placed upwind of dirty areas. If a radical wind shift is predicted during decontamination operations, the setup should be adaptable to allow for quick rearrangement.

Keeping track of the existing wind direction during the decontamination operation is the responsibility of the site noncommissioned officer-in-charge (NCOIC). One of the best means of doing this is to attach short strips of the yellow marking ribbon to mounting stakes from the M274 Contamination Sign Kit or attach white engineering tape to tent poles, tent ropes, etc. One of these wind direction devices must be visible from the hot line when looking in any direction.

Moving the PDS must be considered if the wind shifts more than 30° from the prevailing wind direction. Wind shifts often are transient, so it is advisable to wait 10 to 15 minutes to see if the wind goes back to its original direction. Coordination for the disruption of patient flow and diversion during this waiting period should be considered in the preplanning phase.

Often wind speed will be less than 5 mph for long periods. During these calm atmospheric conditions, chemical agent vapors will drift in almost any direction, so planners must consider moving the decontamination site well outside the base cluster or support areas so that it will not adversely affect other units or the ongoing conventional medical mission of the MTF.

Protection and Monitoring During Setup

Outside a 1-km stand-off distance from the edge of the predicted downwind hazard area, all personnel can remain in MOPP 2 during the setup of the decontamination site. In this area, the site should be free from both liquid and vapor contamination. It is recommended that one soldier in MOPP 4 conduct continuous monitoring during site setup at a location at least 1 km away. This soldier should use the JCAD or M22 ACADA regardless of which agent has been reported (initial NBC1 observer's reports received at the tactical operations center during testing scenarios and field training exercises often contain incorrect information about which agent was actually encountered). As long as the monitor continues to

report no contact with chemical agent vapors, all personnel can remain in MOPP 2 until the first casualties are 5 to 10 minutes away.

If the selected site is within the 1-km stand-off distance or within the predicted downwind vapor hazard area, all personnel must be in MOPP 3 or 4 during site setup. Modification of the MOPP level based on temperature and expected workload during setup can be accomplished as described in FM 3-11.4, *Multiservice Tactics, Techniques, and Procedures for Nuclear, Biological, and Chemical (NBC) Protection*, Chapter 4, Mission-Oriented Protective Posture Analysis. If the site must be set up in the vapor hazard area, it is critical that the selected site be free of liquid contamination. As long as the team sent to the selected site remains completely outside the predicted liquid hazard area, and optimally outside the stand-off distance, a point chemical survey should take no longer than a few minutes using M8 chemical detector paper.

Site Preparation Phase

Site preparation will require time for shuffle pit preparation, dirty dump preparation, and removal of any ground obstacles (see discussions below). If the medical platoon has the time to accomplish any of this labor-intensive work prior to activating a PDS, the decontamination mission will be much more efficient. If no time for this preparation is available, a ground reconnaissance must take place prior to site activation. A simplified PDS diagram is shown in Figure 10-1 (see Appendix D for a detailed foldout). All vehicle movement routes must be marked, points along the route requiring direction indicators identified, and any ground obstacles identified for removal. The arrival or triage area must be surveyed to ensure it can handle the evacuation vehicles moving into and out of the area, plus the activities of the triage officer and the litter teams.

Both the litter and ambulatory decontamination areas must be surveyed to ensure ease of movement by medical personnel, augmentees, and ambulatory patients. The ambulatory decontamination area must be evaluated for the best location of direction indicators to facilitate patient movement through the

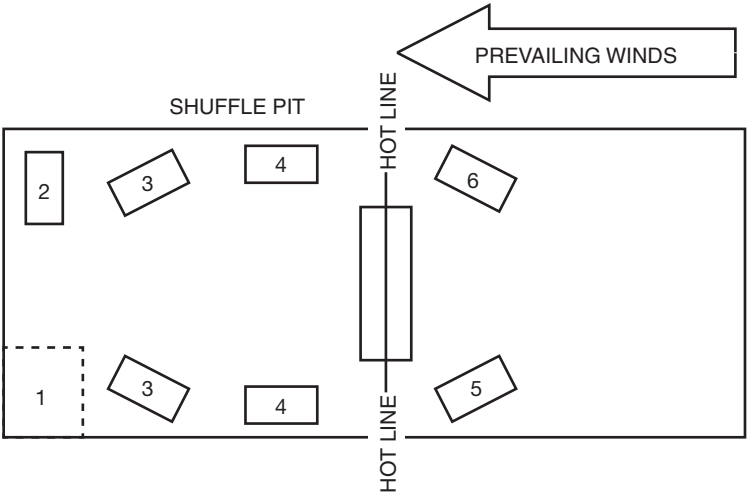

Figure 10-1. Decontamination site diagram. Numbered areas are for:
1. triage
2. emergency treatment
3. clothing removal
4. skin decontamination
5. clean treatment
6. patient hold

various steps, as well as for any obstacle that might impede foot traffic. Ideally, tentage should be set up over the decontamination and decontamination check areas of the decontamination line to shield unclothed patients against the elements. The site must also be evaluated for night operations. Also, a site for supplies should be made near the treatment area for rapid replacement. The supplies should be covered to prevent contamination and allow for reprocessing.

When preparing the site, two or three shuffle pits need to be prepared, each requiring at least two 50-lb drums of super tropical bleach (STB). These pits, depending on the amount of use they get, must be refreshed with STB once every hour or after 10 people have shuffled through them. To refresh a shuffle pit, mix half the original ratio of two shovels of STB and three

shovels of dirt back into the pit (eg, if a shuffle pit originally took 30 shovels of STB and 45 shovels of earth to construct, 15 shovels of STB and 22 [rounded down for safety] shovels of earth would be needed to refresh the pit).

NOTE: *If Reactive Skin Decontamination Lotion (RSDL) is used for patient decontamination, it must* ***NOT*** *be stored near the STB powder because RSDL will cause STB powder, which is highly reactive, to ignite. RSDL can be applied to a casualty on a litter stand that is above the shuffle pit.*

The preparation of the dirty dump is the most labor-intensive effort in the preparation phase. If engineering support is not available, dedicated engineering tools must be available to assist in digging the dirty dump, including saws, axes, pry bars, and long-handled shovels. These dedicated tools must be obtained prior to deployment and used exclusively by the medical treatment squad for site preparation. This will ensure that tools are available at the critical time. Pick axes and long-handled shovels are more appropriate than individual entrenching tools. The use of heavy equipment, if available, will expedite the setup. When setting up in a forest location, it may become necessary to clear low hanging branches, brush, or other ground obstacles. After site preparation is complete, all tools must be kept on the clean side of the hot line.

Security of Decontamination Site

The same security considerations apply when choosing a PDS as with any other medical operation. A decontamination site has the same potential attack risks as the MTF. To evaluate security risks, the officer-in-charge (OIC) or NCOIC should answer the following questions:

- What is the commander's estimate of possible enemy contact?
- What information does the S2 (intelligence officer) have on enemy weapons and tactics?
- Can the site be defended?
- What available terrain or structures can enhance the defense of the decontamination site?

- Is the site overly accessible (eg, is it sitting on a hill or directly adjacent to a busy road where access is not controlled, can the site be seen from a distance)?
- Can the site be quickly evacuated if necessary?
- Can key locations be sandbagged for added protection?
- Will the site be located in an area under light discipline?
- Will the decontamination operation be functional in complete darkness?
- Are communication means available for medical or operational emergencies?
- Can the primary supported unit protect the PDS with augmentation as needed?
- Will dirty evacuation assets (ambulance or rotor wing aircraft) be available to take some patients to the next role of care for decontamination?

Access and Movement Control

An entry control point (ECP) must be established to control movement into the MTF or the PDS. Engineering controls such as concertina wire or other sturdy fencing material should be used when available to restrict travel across the hot line to the clean area, allowing access only through a guarded ECP. The ECP should be located at a distance far enough from the MTF to minimize any vapor hazard that may occur from contaminated vehicles stopping at this point. Without extensive chemical agent monitoring ability, rapid decisions must be made about which vehicles and vehicle contents are contaminated and must proceed to the decontamination site, and which are clean and may proceed directly to the MTF. To facilitate identification of evacuation vehicles carrying clean or contaminated casualties, prior direct coordination between the MTF and supporting evacuation units, both air and ground, following a standardized identification method, must occur. This coordination should happen prior to deployment. Alternatively, all transport vehicles may be considered to be contaminated, despite actual risk, to allow for increased flow of passengers through the ambulatory decontamination line and possibly prevent accidental clean side exposure.

One option for identifying vehicles is to use fabricated metal triangles with NATO standard dimensions (28 cm x 20 cm x 20 cm). The triangles can be camouflaged by painting them with flat green chemical agent resistant coating (CARC) paint. On the three separate triangles, paint the words "ATOM," "BIO," or "GAS" in flat black CARC paint. This will give the evacuation vehicle crew the ability to designate the casualty type as nuclear, biological or chemical. Attach the triangles to the front end of the evacuation vehicle so that the ECP personnel can observe it at a distance. In night operations, use "chem-lights": yellow for chemical casualties, blue for biological casualties, and red for radiation casualties. Attach the light to the front end of the vehicle, below the level of the hood, to reduce its interference with the driver's night vision.

The soldiers staffing the ECP should be in MOPP 4 and equipped with binoculars and night vision goggles for standoff inspection (from a safe distance) of the approaching evacuation vehicle. Once the vehicle halts at the ECP, the soldiers should cautiously approach the vehicle, noting the vehicle crew's MOPP level and, regardless of MOPP level, question the crew about any patient signs or symptoms related to agent exposure and about the vehicle's contamination status. ECP staff should then do the following:

1. Visually inspect the vehicle at the ECP and test any suspicious liquids with M8 or M9 detector paper to make a rapid determination of whether or not a liquid chemical agent is present on or in a vehicle.
2. Use the ICAM to detect vapor coming from any liquid contamination on or in a vehicle. Areas likely to have liquid contamination are the vehicle's rear portion, wheel well areas, and tires.

If the outside of the vehicle is contaminated and the patient must be transported to the next role of care, plans must be in place to transfer the casualty from the contaminated vehicle to another without outside contamination. Nonstandard evacuation platforms can be used if adequate ambulance assets are not available. The dirty vehicle will then return to the battlefield to pick up more contaminated patients. The commander may want

to restrict vehicles with exterior contamination from moving through the unit area. Litter teams may also be utilized to transfer casualties. As a last resort, the contaminated evacuation vehicle may be routed into the PDS along a route that has minimal impact on vehicle movement into the MTF.

Control of vehicle movement to specific routes and areas within the PDS is a critical safety issue, even during combat operations. It can involve routing vehicles along a clearly marked, one-way path from the ECP to the chemical casualty decontamination site. Ideally, return to the ECP should be along the same route. If vehicles are not kept on the proper path, clean areas are likely to become contaminated, and both patients and personnel are at risk of being hit by vehicles during night operations. Planning for vehicle movement must always include night operations and operations in low visibility conditions.

Control of personnel movement is necessary to ensure that casualties and site personnel do not accidentally cross the hot line without first being decontaminated and to secure the PDS and MTF sites from enemy infiltrators. Concertina wire works well to keep personnel in the desired areas, and a clearly marked, one-way route helps to ensure that correct entry and exit points are used. To reinforce the physical barriers in place, night operations must also use visual control measures that conform to light discipline guidelines.

Supplies and Equipment

Only the minimum amount of equipment needed to support patient decontamination should be set up on the designated dirty side of the hot line, as well as the minimum amount of medical supplies needed to support the contaminated emergency treatment point. Having an advance knowledge of the numbers of casualties and types of injuries expected is very helpful in logistical planning, but not always possible. Practicing procedures for the resupply of the PDS from the clean side of the hot line is important. Some supplies should be positioned in the decontamination area, but a majority should be covered and prepositioned in kits on the clean side of the hot line (open these prior to the arrival of the first casualty). These supplies are handed to personnel working on the dirty side, as needed, to replace used supplies as the numbers

of patients increase. This may prevent unnecessary disposal of large numbers of medical supplies that might be considered contaminated if they were positioned in the contaminated PDS area and never used. Also, by keeping equipment and supplies to the minimum required, fewer items must be dealt with during disestablishment of the decontamination site.

Typical Role 1 Army medical platoons are equipped with three different medical equipment sets, for (1) tactical combat medical care, (2) chemical agent patient treatment, and (3) chemical agent patient decontamination. These sets provide a planning factor (for how long supplies will last) of 2 days, or 48 hours, of class VIII supplies. Chemical agent sets include supplies for decontaminating 60 and treating 30 patients. Units are fielded equipment based on their modified table of organization and equipment (MTOE). Larger units will have higher quantities of equipment items. Note: the tactical combat medical care set can easily be depleted during a single mass casualty incident. The sets will service specific numbers of soldiers based upon the facility's role of care. Below are lists of supplies to position at various stations in the PDS. Item quantities should be based on projected throughput.

Entry Control Point

- field medical card (carried by triage officer)
- RSDL (carried by triage officer)
- litters (decontaminable or canvas litters with sacrificial coverings)
- tactile (7 or 14 mm) chemical protective gloves (one pair worn and one carried by the triage officer)
- M8 Chemical Agent Detector Paper (one booklet carried by one member of each litter team and one carried by the triage officer)

If ambulances organic to the unit are used to transport casualties from collection points inside the attack or hazard area to the PDS, it is highly unlikely that these same ambulances, which may require decontamination, would be used to evacuate clean casualties to the next role of health service support. In this situation, remove the four patient protective wraps authorized

per vehicle from each ambulance and hold them on the clean side of the hot line for use in transporting undressed decontaminated casualties in designated dirty evacuation assets, or through possible areas of contamination, to the next role of care.

Emergency Treatment Areas (Clean and Dirty)

- RSDL
- Antidote Treatment Nerve Agent Autoinjectors (ATNAAs)
- atropine autoinjectors
- Convulsant Antidote, Nerve Agent (CANA)
- 50-mL syringes
- adult stethoscope
- flashlight
- field intravenous (IV) poles
- IV bags
- IV sets
- catheter/needle units
- povidone iodine pads
- constricting bands (use with one patient only because it is impossible to ensure decontamination between patients)
- adhesive tape (to secure the IV)
- field dressings
- 11 ¾″ first-aid dressing
- 7 ¼″ angled bandage scissors
- crichothyroidotomy cannula kits
- large and small airway pharyngeals
- hand-operated resuscitator

The Resuscitation Device, Individual Chemical (RDIC) is the best hand-operated resuscitator for use on the dirty side of the hot line. RDICs are included in ground ambulance equipment and the chemical agent patient treatment set.

Litter and Ambulatory Patient Decontamination Lines

- large trash bags for contaminated waste
- bucket of 5% hypochlorite decontamination solution
- bucket of soap and water decontamination solution, RSDL (preferably) or 0.5% hypochlorite solution

- bandage scissors or long-handled seatbelt cutter with blade replacements
- self-sealing plastic bags for field medical cards and personal effects found in outer and inner garments
- sponges
- toxicological agent protective (TAP) decontamination apron
- decontaminable litter for patient exchange (one per patient expected)
- RSDL (one to three applicators per patient)
- M295 Individual Equipment Decontamination Kit (one per patient)
- liquid soap
- litter stands (a pair) to steady patients
- replacement bandages, tourniquets, and splints (as necessary)

Listed below are optional items that are not found in the patient decontamination list but may be useful:

- trash can to hold large garbage bags (if space is available)
- bucket of rinse water
- additional canteens of water for decontamination team members
- 3″ x 5″ card and pen (to list personal effects per patient) or permanent markers (to mark outside of personal effects self-sealing plastic bags)
- chairs to steady standing patients

NOTE: *Prepare additional quantities of soap and bleach decontamination solutions and store in sealed containers to refill buckets.*

Personnel Requirements

Provided below is a minimum suggested list of personnel to staff the PDS. The total number is 30 to 39 soldiers. Although a fully effective litter decontamination procedure can be performed by just two augmentees and triage can be handled with minimal staff, planning must include staffing for both the operational and support staff.

Command and Control Cell

- one officer
- one NCOIC safety officer

NOTE: *The individual appointed as the safety officer must be able to move freely throughout the dirty area of the PDS to check with personnel and ensure that they are not showing symptoms of heat stress and are following safe patient handling procedures.*

Entry Control Point

- two (optional) security personnel
- eight augmentees to unload litter patients (two teams of four)
- two additional (optional) security guards at arrival point to perform pat-down search
- three (optional) road guides and lookouts (night operations)

Triage and Emergency Medical Treatment Area (Dirty Side)

- one senior healthcare NCO or other primary triage officer (physician assistant or nurse)
- one medical personnel to administer treatment
- eight augmentees to serve as litter bearers (two teams of four personnel)

Litter Decontamination Area (Per Litter Lane)

- four augmentees (wearing TAP aprons) to decontaminate the casualties and perform patient lifts
- one medical personnel
- one (optional) augmentee to clean litters

Ambulatory Decontamination Area (Per Lane)

- one (optional) augmentee to assist patients
- one medical personnel

Contamination Check Area

- one augmentee trained to use various contamination detection tools

Hot Line Patient Reception (Clean Side)

- two augmentees to move litter patient across hot line
- one healthcare specialist

Work/Rest Considerations

Work/rest cycles have a direct impact on personnel efficiency and replacement requirements. A complete understanding of the available information on this subject, coupled with common sense and experience, will enhance the planning process and address workforce needs. Establishing a work/rest cycle is dependent on several factors:

- How rested are the soldiers at the outset of operations?
- Have the soldiers been acclimated?
- Has a command drinking policy been in effect regardless of MOPP level (affecting how well hydrated the soldiers are)?
- What is the anticipated relative humidity?
- What is the anticipated temperature?
- Will overhead cover (shade) be available?
- How many heat casualties will the commander accept?

Further information can be found in FM 3-11.4.

Operations and Patient Flow

Dirty Side Triage Area

Once casualties are inbound, personnel working in the triage area are at MOPP 4. Field ambulances approach the triage point from a downwind direction (see discussion of ECP, above). After the arrival of casualties, the entire decontamination site on the downwind side of the hot line must be considered a liquid/vapor hazard area. Patients are off-loaded from the ambulances and taken to the triage point. The patients are triaged and visibly marked with prepared tags or adhesive tapes using the following colors to denote triage casualties:

- immediate: red
- delayed: yellow
- minimal: green
- expectant: black

These colors can also be used for triage with chem-lights in night operations, with the exception that the expectant casualty would be marked with a blue chem-light. Unless the casualty is in respiratory distress, requiring intubation on the dirty side, or has wounds that prohibit masking, unmasked patients must be masked immediately at this point.

At the triage area, all military gear (protective mask carrier, Kevlar [DuPont, Wilmington, DE] vest and helmet, load-bearing equipment, weapon, and all types of armament) must be removed from both litter and ambulatory casualties. A pat-down search of the casualty's body, especially the chest and all pockets, is important to locate any ordinance carried by soldiers or explosive devices carried by disguised terrorists. After triage, the casualty will be directed to the ambulatory decontamination line, litter casualty decontamination line, or the dirty side emergency medical treatment (EMT) station. The mask is kept on the patient unless removal is clinically indicated.

Dirty Side Emergency Treatment Area

The EMT station should be established upwind from the triage point and to the side of the decontamination site perpendicular to the prevailing wind direction. It should be positioned as far to the side of the decontamination site as is practical. This setup will allow the EMT station to be away from the heaviest concentration of vapor resulting from the evaporation of liquid chemical agents concentrated at the triage point. It should also be an area that is expandable, depending on the influx of patients that need to be treated and stabilized. All personnel rendering EMT assistance will be at MOPP 4.

Treatment at the EMT station is limited to administering ATNAAs and diazepam, applying pressure dressings, establishing a patent airway, and starting an IV infusion. If

immediate clearing of the airway must be done at this point to save the patient's life, the airway is cleared and the mask replaced, or the patient is intubated. After this lifesaving procedure, it may or may not be necessary to change the triage category of the patient to reflect the increased burden of the exposure or the improved condition of the casualty.

Casualty Decontamination

Personnel working in the casualty decontamination areas will be at MOPP 4. Only the soldiers performing litter patient decontamination should wear the TAP apron over their IPE to keep it dry. Any additional gear (helmets and body armor, load-bearing equipment, protective mask carrier, and weapons) should be kept on the clean side of the hot line. Each soldier should carry three ATNAAs, one diazepam auto-injector (CANA), one package of RSDL, and one booklet of M8 detection paper in the cargo pockets of their overgarment trousers.

NOTE: *Two people (not including litter team) will work with each patient, tracking the patient from the first decontamination step to hand-over at the hot line.*

Two different concentrations of bleach solution are used in the patient decontamination procedure. A 5% bleach solution is used to decontaminate scissors and other cutting devices, TAP aprons, litters, and the gloves of personnel working in patient decontamination. The bleach solution is placed in the 3-quart plastic buckets issued with the patient decontamination medical equipment set. The buckets should be distinctly marked to distinguish the 5% solution from either the 0.5% bleach solution or soap and water. Preparation of these solutions is covered in Appendix B, Preparation of Patient Decontamination Solutions. Bleach evaporates quickly at high temperatures and loses its oxidation ability over time, so the solutions should be prepared shortly before they are needed. See the attachment to this chapter for step-by-step decontamination instructions.

Dirty Zone Rest and Rehydration Point

An area should be established 50 m perpendicular to the litter casualty decontamination line and approximately 5 m from the hot line for workers to use as a rest and rehydration point. If possible, this rest point should have overhead cover for shade. Before using this area, workers must decontaminate their TAP aprons using a 5% bleach solution and doff the apron near the decontamination line. Before removing the apron, gloves must be decontaminated with the M295 kit, RSDL, or 5% bleach solution. The aprons should be hung up so they can air out and be worn again. Next, workers must decontaminate their chemical protective boots by using an M295 kit or moving through a shuffle pit dug for this area. After completing this decontamination process, the soldiers move to the rest and rehydration point and begin rehydration using their mask's drinking system. Soldiers should not group together in this area, but should stay 3 m apart.

Clean Side Resupply Point

Of equal importance to the casualty decontamination effort is the logistical support of the ongoing operation. A logistics support point is established upwind within 30 to 50 m of the hot line. At this point, the soapy water and hypochlorite (bleach) solutions are prepared. All the soldiers staffing the site also stockpile 1- or 2-quart canteens for use by decontamination team members. These canteens must be fitted with caps that support the mask drinking system. The logistics support point should have one 400-gallon water buffalo or, initially, twenty 5-gallon water cans. Medical supply, chemical casualty treatment, and decontamination medical equipment sets can be located in this area along with additional supplies.

Contaminated Waste Dump Area

The dirty dump is located a minimum of 75 m downwind from the triage and emergency medical treatment areas. Prepare the dump ahead of time; it is a manual, labor-intensive job if no engineering support is available (see site prep section, above). Initially the dirty dump is a hole 4 ft wide on each side and 5 ft

deep. All personnel working in and around the dirty dump must be at MOPP 4 once casualties begin to arrive at the site. When the PDS is closed and the dirty dump is backfilled, its location must be reported (using an NBC5 report) to higher headquarters as a contaminated site with an 8- or 10-digit grid coordinate.

Disestablishing the Patient Decontamination Station

The closure of the patient decontamination site will pose as difficult a mission as the actual decontamination effort itself, due in large part to the physical condition of the medical personnel and non-medical augmentees. Fatigue will cause site personnel to move slower and make mistakes. Regardless of the number of times command drinking was done, most of the site personnel will be dehydrated. Dehydration will lower performance and stamina while increasing the likelihood of heat injuries. Disestablishing the site must be done carefully to prevent heat casualties among the personnel.

Prolonged encapsulation in the MOPP gear may distort tempers, attitudes, and motivation. Any plans made to disestablish the PDS must be simple and quick; personnel will not be able to sustain an involved and detailed process.

The three areas of concern during closure are equipment recovery, site closure, and personnel recovery. Efforts must be prioritized to optimize the recovery of essential equipment versus expendable equipment, to deny threat forces tactical intelligence, and to ensure that site personnel complete required work and emerge from total encapsulation as quickly and safely as possible.

Equipment and Personnel Recovery and Site Closure

Decontamination and monitoring of the equipment can take place adjacent to the hot line and 50 m to the left or right of the litter and ambulatory decontamination areas. Recommended equipment for recovery is as follows:

- large trash bags for contaminated waste
- a slurry mixture of STB or 5% hypochlorite (full-strength household liquid bleach) solution (in buckets)

- buckets for STB slurry or hypochlorite solution
- buckets for rinse water
- sponges or rags
- TAP aprons
- entrenching tools

To prepare the STB slurry mix, use two parts STB mixed into three parts water (by weight). For example, 6 gallons of water weighs 42 lb (1 gallon = 7 lb), which is mixed with 28 pounds of STB. The slurry mixture or 5% bleach solution must be scrubbed onto the items requiring decontamination and allowed to remain on the surface for 30 minutes. After this contact time, the items must be flushed with clean water.

If the mission permits, the following items can be decontaminated for reuse:

- decontaminable litters
- litter support stands
- 12-quart steel utility pails
- TAP aprons
- field IV poles
- flashlights
- RDICs
- ICAMs

While waiting for the 30-minute contact time to elapse, all other items on the dirty side of the hot line can be placed in a plastic garbage bag and put in the dirty dump. Several personnel must conduct a police call of the arrival/triage area and litter and ambulatory decontamination areas.

After the 30-minute contact time has elapsed and all items have been flushed with clean water, each item must be monitored before it is passed over the hot line. Ensure that cracks, joints or seams, bolts, porous materials, and any openings are monitored in addition to surface areas of the equipment items.

Upon completion of equipment recovery, all personnel except for two will conduct MOPP gear exchange at a site selected by the site NCOIC or OIC adjacent to the hot line and 50 m opposite the side used to decontaminate equipment. MOPP gear

will be exchanged with the unit supplying required support. After completing MOPP gear exchange, the two remaining personnel will put all discarded MOPP gear into plastic bags and place them in the dirty dump. Then they will backfill the dirty dump, covering it with earth, mark it with hazard signs, and mark its location on a map with coordinates relayed to higher headquarters. These two personnel will then move back to the hot line and perform their own MOPP gear exchange. The remaining two sets of discarded MOPP gear are left in place and camouflaged.

Once all tasks have been completed, the area can be closed.

NOTE: *Two personnel from the clean side of the hot line should complete these actions because dirty side personnel will be fatigued.*

ATTACHMENT: STEP-BY-STEP GUIDES TO LITTER AND AMBULATORY PATIENT DECONTAMINATION

Decontamination of litter and ambulatory casualties closely follows the methods described in FM 4-02.7, *Multiservice Tactics, Techniques, and Procedures for Health Service Support in a Chemical, Biological, Radiological, and Nuclear Environment*, and FM 3-11.5, *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Decontamination*. The step-by-step procedures outlined below are the prescribed doctrine for decontaminating litter and ambulatory patients, but they are by no means the only methods. Knowing these methods, however, ensures that correct and essential steps are not omitted; if the steps cannot be followed (eg, if responders are a mix of military and civilian personnel), other measures discussed here can be taken to preclude a hazardous outcome.

RSDL or a soap solution and water are used for chemical contamination on the skin. The least desired alternative for skin decontamination is bleach (hypochlorite solution). A 0.5% hypochlorite solution with water rinse is useful if water is limited and RSDL is not available. Only use a 0.5% hypochlorite solution for skin decontamination; higher concentrations will irritate and burn the skin, allowing agents to enter the skin more rapidly.

The M295 Individual Equipment Decontamination Kit is used to remove obvious contamination from the patient and help to control the spread of contamination on IPE (MOPP ensemble) and other equipment. If it is not available, then either soap solution or a field-expedient adsorbent material, such as clean, dry earth or flour, can be substituted.

Litter Casualty Decontamination

Step 1. Clothing removal

1. Decontaminate mask and hood.
   a. Wipe or sponge down the voicemitter, eyelets, and outserts with RSDL or 5% bleach solution. While wiping around the filter, momentarily cover the filter's inlet with your hand to keep liquid out of the inside of the filter, where it could wet the charcoal, reduce filter efficiency, and clog the filter.
   b. Hoods are of two types: those that are part of the overgarment and those attached to the mask.
      i. For integral hoods that are part of the overgarment, such as the Joint Service Lightweight Integrated Suit Technology (JSLIST) type II, no decontamination is necessary.
      ii. For hoods attached to the mask, first wipe down the hood using 5% bleach solution, starting at the top of the head and wiping down toward the shoulders.

NOTE: *When the M295 kit or RSDL are not available or are in limited supply, use a 5% bleach solution on equipment.*

2. Remove hood.
   a. Start with a cutting device soaking in a bucket of 5% bleach solution (or decontaminate the cutting tool with the M295 kit or RSDL).
   b. Cut the hood starting at the front center and continue cutting across the top of the head toward the litter (Figure 10-2).
   c. Fold the left and right sides of the hood away from the head on the litter.

NOTE: *To cut the hood and JSLIST, use scissors or a combat strap cutter. After every complete segmental cut (eg, cutting the sleeve from the cuff to the jacket collar), the cutting tools and the gloved hands of the soldier doing the cutting must be decontaminated. Put the cutting device in a bucket of 5% hypochlorite solution after each complete line of cut and get another cutting tool from the hypochlorite solution bucket for the next cut. If a bucket of 5% hypochlorite solution is not available, the cutting tools must be scrubbed using the M295 kit between each cut or rinsed thoroughly in running soapy water. Cutting tools must be replaced*

Figure 10-2. Cutting the hood.
Cut line: — — —

once they no longer make a smooth cut. Use soap and water, RSDL, or 0.5% bleach solution on skin or equipment items that will contact skin.

3. Decontaminate head.
   a. Use soap and water, RSDL, or 0.5% bleach solution.
   b. Leaving the mask on the patient, cover the inlet port of its filter to keep it from getting wet or congested.
   c. Wipe any exposed areas of patient's face that were not protected by the hood, including chin, neck, and back of ears.
4. Remove the field medical card (FMC).
   a. The care provider at the litter patient decontamination station should view the FMC prior to removal.
   b. Cut the FMC tie wire.
   c. Allow the FMC to fall into a self-sealing plastic bag.
   d. Seal the plastic bag and decontaminate the outside of the bag.

e. Place the plastic bag under the back of the patient's mask head harness straps.

5. Remove personal articles from the pockets of the JSLIST.
   a. Place the articles in self-sealing bags.
   b. Label the bags with the patient's name and assigned identification number. Other items, from inside pockets, will be added to the bags later in the process.
   c. Decontaminate gloves before and after handling the bags.

NOTE: *The patient's identification tags stay around the patient's neck throughout the decontamination process. They are decontaminated with soap and water, RSDL, or 0.5% bleach.*

6. Cut patient's JSLIST.
   a. Cut overgarment around tourniquets, bandages, and splints (two people will be cutting the overgarment at the same time).
   b. Remove the JSLIST jacket by cutting it off.
      i. Unfasten or cut hook-and-pile wrist closure at the wrist.
      ii. Make two cuts, one up each sleeve from the wrist to the shoulder, and then to the collar. Keep the cuts close to the inside of the arms so that most of the sleeve material is folded outward (Figure 10-3).
      iii. Cut the jacket drawstring at the bottom of the jacket and unfasten hook-and-pile closures, moving from waist to neck, and then unzip the jacket.
      iv. If the casualty is able, instruct them to hold their arms up and away from their body, and drape the left and right chest sections of the jacket over the outside of the litter.
      v. Then instruct the casualty to keep their hands to their sides, away from the areas where the JSLIST has been removed.
      vi. If the casualty is unable to lift their arms, one augmentee will hold the casualty's gloved hand and perform this action. Another augmentee folds the chest sections over the outside of the litter. The patient's arms are then lowered to the sides, keeping the gloves away from the area where the jacket has been removed.

Figure 10-3. Cut lines for removing the Joint Service Lightweight Integrated Suit Technology jacket.
Cut line: — — —

c. Remove the JSLIST trousers.
   i. Cut the suspenders.
   ii. Unfasten the hook-and-pile closure at the ankle cuff.
   iii. Cut from the ankle along the inseam of the left trouser leg until the crotch area is reached, then cut across into the zipper (Figure 10-4).
   iv. Cut along the inseam of the right trouser leg until the crotch area is reached, then go sideways into the first cut.
   v. Allow trouser halves to drape over the side of the litter.
   vi. Tuck the remaining cloth between the legs by rolling it, while ensuring that only the black lining is showing.

7. Remove the outer gloves. Do not remove the inner gloves.
   a. Decontaminate your own gloves with the M295 kit, RSDL,

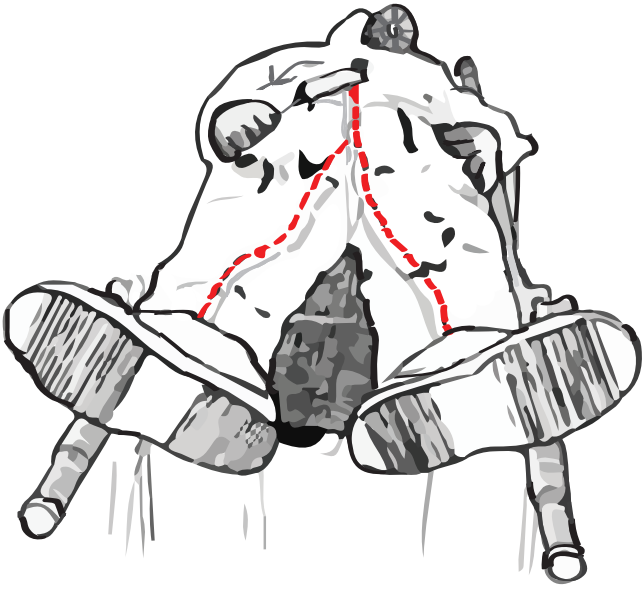

Figure 10-4. Cut lines for removing the Joint Service Lightweight Integrated Suit Technology trousers.
Cut line: — — —

or 5% bleach solution.

b. Decontaminate the casualty's gloves with the M295 kit, RSDL, or 5% bleach solution.
c. Instruct the casualty to hold their arms away from the litter and upper body or, if they cannot comply, hold their gloves by the fingers.

NOTE: *Always remove the gloves over the sides of the litter.*

d. Grasp the cuff of the glove, turning the glove inside out, and remove it (Figure 10-5).
e. Carefully lower the patient's arm across their chest as each glove is removed. Avoid touching the patient's cloth glove liner or arm with your rubber glove.

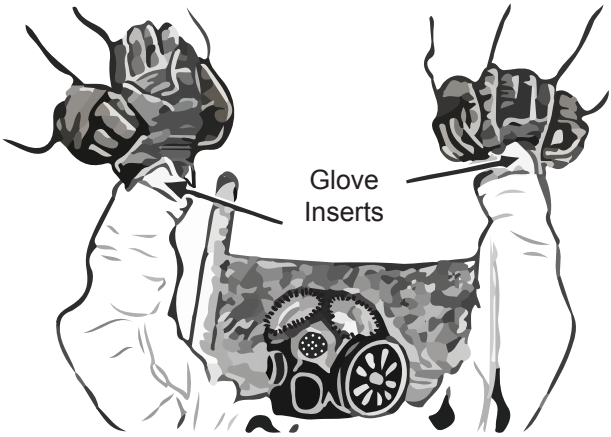

Figure 10-5. Removing the outer gloves.

CAUTION: *Do not allow the arms to contact the exterior (camouflage) side of the overgarment*.

f. Dispose of the contaminated gloves by placing them in a trash bag.
g. Decontaminate your own gloves with the M295 kit, RSDL, or 5% bleach solution.

8. Remove the overboots.
   a. Unfasten the overboots.
   b. Gently pull the overboot by the heel until it is removed.
   c. If the overboot will not come off, cut the boot from top to bottom along the centerline of the boot or along the inside of the boot. Fold the overboot down and gently pull the heel until it is removed. Place the overboots in the contaminated trash.
9. Remove personal effects from the JSLIST.

NOTE: *Remember to decontaminate your gloves first*.

a. Place personal effects in a self-sealing plastic bag.
b. Remove the bag to the contaminated holding area.

10. Remove combat boots without touching body surfaces.
    a. Cut the boot laces along the tongue.
    b. Pull the boots downward and toward you until they are removed.
    c. Place the boots in the plastic bag containing the chemical overboots and gloves.
11. Remove inner clothing.
    a. Cut or unbuckle the belt.
    b. Cut the duty uniform pants following the same procedures as for the overgarment trousers.
    c. Cut the duty uniform jacket following the same procedures as for the overgarment jacket.
12. Remove undergarments.
    a. Remove the patient's T-shirt.
        i. Decontaminate gloves and scissors with the M295 kit or RSDL, or immerse cutting devices in a bucket of 5% bleach solution between each complete cut.
        ii. Cut up the front of the patient's T-shirt from the waist up to the collar.
        iii. Cut both sleeves from the inside, starting at the elbow, up to the shoulder, and then to the collar.
        iv. Cut around bandages or splints, leaving them in place.
        v. Next, gently peel the T-shirt away from the body to avoid spreading any contamination.
    b. Remove the patient's brassiere.
        i. Decontaminate gloves and scissors.
        ii. Cut brassiere between the cups.
        iii. Cut both shoulder straps where they attach to the cups and remove the brassiere.
    c. Remove the patient's undershorts or panties.
        i. Decontaminate gloves and scissors.
        ii. Cut from the lower side of the hip to the waist on both sides.
        iii. Place the undergarments into the plastic garbage bag containing the other contaminated items.
13. Remove socks. Place them in the plastic garbage bag.
14. Remove inner gloves. Place them in the plastic garbage bag.

NOTE: *It is recommended that workers decontaminate each other's TAP aprons, gloves, and lower portion of the protective hood with RSDL or 5% solution between each patient and before any litter transfers. Team members should wash each other, with each person being decontaminated standing with their arms spread out to the sides, allowing the team member performing the decontamination to get into all the folds of the TAP apron front and sleeves.*

Step 2. Litter transfer and decontamination

1. After decontaminating one another's TAP aprons, team members will now use a patient-lift to move the unclothed patient to a clean litter, where skin decontamination will occur. Before and during the lift, the leader explains to the casualty exactly what is going to happen.
2. Decontamination team members position themselves with one person on one side of the litter and three on the other.
3. The single person on one side rolls the patient toward himself or herself.
4. The three on the other side slide their clean arms under the patient (in a forklift fashion), supporting the casualty's neck, torso/lower back, and distal legs. A medic, if present, provides supervision and can assist in neck stabilization.
5. The single person on the first side then rolls the patient back onto the forearms of the other three team members.
6. The medical provider, or an individual at the patient's head, gives the command, "prepare to lift." If ready to lift, the other members reply, "ready." The medic then commands, "lift."
7. To ensure safety during the lift, team members keep their backs as straight as possible and perpendicular to the ground, and lift using their legs and arms.
8. The patient is lifted up and rolled slightly inward against the lifters' chests to reduce the effort and better support the patient.
9. The dirty litter and its contaminated clothing are removed from the litter stands, and a clean, decontaminable litter is placed under the patient by the lone augmentee.
10. The medic then gives the command, "prepare to lower." If ready, the other team members respond, "ready." The command to "lower" is then given, and the patient is slowly lowered onto the clean litter.

11. The cut overgarment and undergarments from under the patient are now placed in the plastic garbage bag with the other waste from the casualty.

NOTE: *Contaminated material from two litter patients can be placed into one 35-gallon trash bag. The remaining 5% bleach solution and soapy water (if used) can be poured into the bags. The bag must be tied shut and transported to the dirty dump.*

12. The dirty litter is decontaminated with an M295 kit or a 5% bleach solution with a water rinse. It remains on the dirty side to be reused for transferring other casualties from the triage area to the litter patient decontamination point.

Step 3. Skin and wound decontamination

1. The casualty is now decontaminated with soap and water, RSDL (for spot decontamination), or 0.5% bleach solution.
2. If the patient was wearing a chemical protective overgarment, decontaminate only those skin areas where there was a break in the garment (eg, around wounds, areas where the underlying uniform is wet with agent, or where there is a tear in the overgarment).
3. If the patient was not wearing IPE or had significant uniform tears or a damaged underlying uniform, decontaminate the entire skin surface by wiping the skin with a sponge and soapy water or 0.5% bleach solution with a water rinse.
   a. Wash the casualty from the midline outward, constantly washing from clean to dirty. Do not place a dirty sponge back on a clean area without first rinsing the sponge. Wash the complete topside of the casualty in this manner, paying particular attention to hairy areas of the body (groin and axillary regions) and sweaty areas (belt-line, just above the boots, the crease of the buttocks, and wrists).
   b. Log-roll the patient onto their side, and wash their backside. Then wash the casualty's back from the shoulders to over halfway down the backside, taking care not to miss any areas.
   c. Decontaminate the upper side of the litter with soap and water, 0.5% bleach, or RSDL prior to rolling the patient onto their back again. Log-roll and wash the opposite

side of the casualty in exactly the same manner and decontaminate the litter before rolling the patient onto their back again.

4. After the casualty is decontaminated, the medic removes dressings and replaces them only if needed.
   a. Superficial wounds (with no involvement of body cavities, eyes, or nervous tissue) are decontaminated with RSDL, flushed with soapy water, or 0.5% bleach solution, and new dressings are applied if needed.
   b. Larger wounds are irrigated, if contaminated, with sterile water or IV saline to remove contaminants. Then cover the wounds with a large dressing and plastic if additional contamination may get into the wound.
   c. Tourniquets that are contaminated are replaced by a qualified medical provider. The new tourniquets are placed 0.5 to 1 inch proximal to the original tourniquet. The old, contaminated tourniquet is removed and put in the waste bag.
   d. Hemostatic dressing should be evaluated by a qualified medical provider and only removed or replaced if potential bleeding can be controlled.
   e. Splints are not removed by augmentees, but are decontaminated with RSDL or saturated to the skin with 0.5% hypochlorite solution and rinsed thoroughly with soapy water. If the splint cannot be saturated (air splint or canvas splint), it must be moved sufficiently or replaced by the care provider to enable everything under it to be decontaminated.

Step 4. Monitor for completeness of decontamination

1. Establish an area between the decontamination area and the hot line to check for thoroughness of patient decontamination before the patient crosses the hot line.
2. Use the ICAM or M8 paper in this area to check for chemical agent contamination and a radiac meter or other appropriate monitoring instruments to check radiological contamination.
3. If contamination is detected, use appropriate decontaminants (RSDL, soap and water, or 0.5% bleach) to spot decontaminate suspected areas.

4. Once the casualty is confirmed clean of any CBRN contamination, the decontamination team again helps one another to ensure that their TAP aprons and gloves are decontaminated and then takes the litter patient to the hot line.

NOTE: *As the dirty team prepares to bring the casualty to the hot line, the team on the clean side opens a blanket or other covering appropriate for the environmental conditions.*

Step 5. The hot line and clean side actions for litter patient

Straddling the hot line is the casualty pass-over point, which is in a shuffle pit.

1. The dirty team brings the decontaminated casualty to the hot line on the litter and places the litter on the stands.
2. In the shuffle pit, the patient's FMC is transcribed by the medic on a new, clean FMC, and the dirty one is taken back to the dirty side by the dirty team.
3. Three dirty team members log-roll the casualty up and off the litter. A fourth dirty team member removes the litter. The clean team replaces the litter with a clean one. The dirty team lowers the casualty onto the clean litter and moves away.
4. After the dirty team moves away, clean team members fold the blanket over the casualty and move the casualty to a holding area 30 to 50 meters upwind.
5. In the clean treatment area, the patient can now be retriaged, treated, and evacuated. In a hot climate, the patient will probably be significantly dehydrated. The rehydration process must begin immediately. Overhead cover should be provided for casualties in the holding area. The mask may now be removed unless circumstances dictate that the casualty remain closer to the hot line.

Ambulatory Casualty Decontamination

NOTE: *Refer to the images in the previous section.*

Step 1. Clothing removal

1. Decontaminate the mask and hood.
   a. Wipe or sponge down the voicemitter, eyelets, and outserts with RSDL or a 5% bleach solution. While wiping around the filter, cover the inlet of the filter with your hand momentarily to keep liquid out of the inside of the canister where it could wet the charcoal, reduce filter efficiency, and clog the filter.
   b. Hoods are of two types: those that are part of the overgarment and those attached to the mask.
      i. For integral hoods that are part of the overgarment, such as the JSLIST type II, no decontamination is necessary.
      ii. For hoods attached to the mask, wipe down the hood using 5% bleach, wiping the mask and then the hood (starting at the top of the head wiping down toward the shoulders).

NOTE: *When the M295 kit or RSDL are not available or are in limited supply, use a 5% bleach solution on equipment.*

2. Remove hood.
   a. Start with the cutting device in a bucket of 5% bleach solution or decontaminate it with the M295 kit or RSDL.
   b. Cut the hood starting at the front center and continue cutting across the top of the head toward the back (see Figure 10-2).
   c. Fold the left and right sides of the hood away from the head and place on the shoulders.

NOTE: *After every complete segmental cut, decontaminate the scissors or combat strap cutter along with the gloved hands of the soldier doing the cutting. This is done by dipping gloved hands and exchanging cutting tools in a bucket of 5% bleach. If ample supplies are available and water is limited, the M295 kit or RSDL can be used.*

3. Decontaminate head.
   a. Use soap and water, RSDL, or 0.5% bleach solution.
   b. Cover inlet port of filter to prevent wetting or congesting it. The patient continues to wear a mask until crossing the vapor control line (vapor may extend past the hot line).

c. Wipe any exposed areas of patient's face that were not protected by the hood, including the chin, neck, and back of ears.

NOTE: *After completing the hood removal, instruct the casualty to move to the next station for the following steps. This station should be 10 to 20 m upwind from the hood removal station.*

4. Remove the FMC.
   a. A medic at the litter patient decontamination station should view the FMC prior to removal.
   b. Cut the FMC tie wire.
   c. Allow the FMC to fall into a self-sealing plastic bag.
   d. Seal the plastic bag and decontaminate the outside of the bag.
   e. Place the plastic bag under the back of the patient's mask head harness straps.
5. Remove personal articles from pockets of JSLIST.
   a. Have the casualty remove all items from the JSLIST jacket and trousers and place them in a self-sealing plastic bag.
   b. Label the bag with the casualty's name and identification number and then move the bag with the patient to the next step in the ambulatory decontamination line.
   c. The patient must decontaminate their gloves before and after handling the bag.

NOTE: *The patients' identification tags stay around their neck throughout the decontamination process. The tags are decontaminated with soap and water, RSDL, M295, or 0.5% bleach.*

6. Remove the casualty's JSLIST.

NOTE: *If there are not enough augmentees to do this job, one augmentee can instruct patients to cut off one another's overgarments. The augmentee must supervise the procedures.*

   a. Cut overgarment around tourniquets, bandages, and splints.
   b. Remove the JSLIST jacket by cutting it off.
      i. The casualty should be standing and can hold onto a support, such as a chair or litter stand.

ii. The individual with a cutting tool (scissors or combat strap cutter) stands in front of the casualty and cuts the patient's IPE.
iii. First, cut around all bandages and tourniquets.
iv. Cut the hook-and-pile wrist closures.
v. Cut the JSLIST draw cord at the jacket bottom.
vi. Cut the JSLIST jacket starting at the waist and cutting toward the collar in a line parallel to the zipper (or unfasten the hook and pile and unzip the zipper). Continue the cut from the hood down the back center of the jacket. This is best done using a seatbelt cutter.
vii. Instruct the casualty to clench their fists and stand with feet shoulder-width apart and arms held down and extended backward at about a 30° angle if the jacket was unzipped or cut in the front. If the jacket was cut along the rear, have the patient extend the arms forward at about a 30° angle.
viii. Grasp the jacket collar at the sides of the neck.
ix. Peel jacket off the shoulders in a down-and-away motion, smoothly pulling the jacket inside out over the casualty's fists.
x. Place the jacket in a plastic trash bag.

NOTE: *The jacket may need to be cut along the sleeve if bandages are in the way and sleeves cannot be rolled over the bandaged area.*

c. Remove the JSLIST trousers.

NOTE: *Do not cut the trouser suspenders until the end of the process so that the trousers do not fall during cutting and get in the way of the cutter.*

i. One augmentee should stand behind the casualty and another, if available, at the front of the casualty. The casualty should hold onto a chair or litter stand.
ii. The easiest way to cut the trousers is from the front. Keep the pants zipped. Unfasten ankle fasteners and begin cutting at the ankle. Cut along the inseam, moving up toward the waist of the trousers (see Figure 10-4).

After cutting both trouser legs from ankle to waist, cut each suspender and allow the trousers to fall to the ground. Take the trousers and lay them on the ground, black side up, next to the patient. Later the patient will step onto them as the overboots are removed.

iii. Another method is to cut the trousers from the rear. In this case, first unfasten the waist tabs. Start the cut at the ankle and move to the waist. Once the cuts on both legs are complete from ankle to waist, cut the suspenders below the suspender cross points and then above the cross points, allowing the trousers to fall to the ground. Lay the trousers on the ground, black side up, next to the patient.

7. Remove the overboots.
   a. Unfasten all boot closures.
   b. Step on the heel of the boot and have the patient step out of the overboot and onto the black side of the cut trousers that are lying on the ground. Repeat this process for both boots. The overboots can be decontaminated and issued to other individuals.
   c. If the overboot will not come off, cut the boot from top to bottom along the centerline of the boot until the boot is loose enough to step out of.
8. Remove the casualty's outer gloves. Do not remove the inner glove liners.
   a. Decontaminate your own gloves with the M295 kit, RSDL, or 5% bleach solution.
   b. Decontaminate the casualty's gloves with the M295 kit, RSDL, or 5% bleach solution.
   c. Instruct the casualty to hold their arms up, if possible, and away from their upper body. If the patient cannot do this, hold their gloves at the fingers.
   d. Grasp the cuff of the glove.
   e. Pull the cuff over the fingers, turning the glove inside out (see Figure 10-5).
   f. Dispose of the contaminated gloves by placing them in a trash bag.
   g. Decontaminate your own gloves again with the M295, RSDL, or 5% bleach solution.

9. Remove inner gloves.
   a. The patient should remove their own inner gloves to reduce the possibility of spreading contamination. The augmentee instructs the casualty to remove the inner glove using the following guidance:
      i. Grasp heel of glove liner without touching exposed skin.
      ii. Peel liner downward and off.
      iii. Drop it into the plastic trash bag.
      iv. Remove the other liner in the same manner and drop it into the plastic trash bag.
      v. The patient then moves to the monitoring station.

NOTE: *Waste material from two ambulatory patients, including the cut trousers, are placed into one 35-gallon trash bag along with the used 5% bleach and soapy water used on the two patients. Tie the bag shut and transport it to the dirty dump.*

Step 2. Monitor duty uniform

1. Monitor the casualty with an ICAM or M8 detection paper.
2. Check all areas of the casualty's clothing and combat boots. Pay particular attention to:

   - boots
   - protective mask
   - hair and neck area
   - discolored areas
   - damp spots
   - wrist closure area
   - areas under tears in the overgarment
   - areas around dressings and splints

3. If clean, send the casualty to the hot line.
4. If contaminated areas are found, decontaminate the areas using RSDL, the M295 kit, or soap and water. If the duty uniform is contaminated, it must be removed (see below). After decontamination, recheck the area again with the ICAM or the M8 detection paper.

Step 3. Remove the duty uniform

1. Remove personal effects from the duty uniform.
   a. Have the casualty remove all items from the duty uniform and deposit them into a self-sealing plastic bag.
   b. Check the personal items for contamination. If not contaminated, they remain with the patient. If contaminated, they are moved to a contaminated item holding area.
2. Remove inner clothing (if contaminated).
   a. Cut or unbuckle belt.
   b. Cut the pants following the same procedures as for the overgarment trousers.
   c. Cut the jacket following the same procedures as for the overgarment jacket.
3. Remove undergarments (if contaminated).
   a. Remove the patient's T-shirt.
      i. Dip cutting devices in 5% bleach solution or scrub them with the M295 kit or the RSDL between each cut.
      ii. Cut around bandages or splints, leaving them in place.
      iii. Cut up the front of the patient's T-shirt from the waist up to the collar.
      iv. Cut both sleeves from the elbow to the shoulder and then to the collar.
      v. Next, peel the T-shirt away from the body to avoid spreading contamination.
   b. Remove the patient's brassiere.
      i. Cut it between the cups.
      ii. Cut both shoulder straps where they attach to the cups and remove the brassiere.
   c. Remove the patient's undershorts or panties.
      i. Cut from the lower side of the hip to the waist on both sides.
      ii. Place the undergarments into the plastic garbage bag containing the other contaminated items.
4. Check the patient for contamination.
   a. After removing the patient's duty uniform and underwear, check the skin, hair, and boots for contamination by using M8 detector paper, ICAM, or radiac meter.

   b. Carefully survey all areas of the patient's skin, paying particular attention to areas around the neck, wrist, ears, dressings, and splints.
5. Perform final decontamination. At the final contamination check area, use RSDL, soap and water, or a 0.5% hypochlorite solution, followed by a water rinse, for any places on the patient that still indicate contamination.
6. A healthcare provider removes any contaminated bandages and tourniquets.
   a. Place new tourniquets 1/2 to 1 inch above the old tourniquets.
   b. Remove old tourniquets.
   c. Decontaminate the exposed skin area.
   d. Cut away bandages. Hemostatic dressings are removed by advanced providers.
   e. Decontaminate the exposed skin area.
   f. Replace bandages as needed to control bleeding.
   g. Decontaminate exposed skin.
7. Conduct final check for completeness of decontamination with the ICAM or M8 paper.
8. Move to the hot line. Instruct the patient to move to the shuffle pit and hot line.

Step 4. The hot line and clean side actions for the ambulatory patient

NOTE: *Shuffle pits straddle the hot line. The shuffle pit is two parts STB and three parts earth (by volume). The ambulatory patient shuffle pit must be wide enough for the patient and two assistants.*

NOTE: *Take steps to reduce the incidence of patient cold injury and hypothermia. In cold conditions, have blankets available on the warm side of the hot line.*

1. At the shuffle pit, an augmentee from the clean side meets the patient and opens a blanket or other covering for the patient appropriate for the environmental conditions.
2. The patient shuffles through the shuffle pit wearing combat boots.

3. Once across the vapor control line, ambulatory patients can remove their mask.
4. In the clean treatment area, the patient is now retriaged, treated, and evacuated.
   a. In a hot climate, the patient will probably be significantly dehydrated. The rehydration process must begin immediately.
   b. Provide overhead for casualties in the holding area. Masks may be removed for treatment unless circumstances dictate that the casualty remain closer to the hot line.
   c. Personnel on the clean side, past the vapor control line, are in MOPP 2 or less.
   d. Patient protective ensemble should not be removed until the patient is medically stable enough to undergo decontamination.
   e. If temperatures are near freezing, use a dry decontaminant (sand, paper towel, M291, or M295) for immediate (gross) decontamination and then move the patient inside a warm area before clothing is removed. Outer protective clothing is removed in a ventilated area immediately outside or near the entrance to the heated room.
   f. If washing the patient's entire body is not necessary, then remove the clothing and decontaminate only the exposed areas. Remember that thicker winter clothing, if worn at the time of exposure, will offer some degree of protection against chemical agents. Thicker clothing offers adequate protection against dry particles and spores.
   g. Once clothing removal begins, make the decontamination process as fast as possible.
   h. If a structure is available, conduct patient thorough decontamination operations inside a heated area using warm soapy water.

Chapter 11

INDIVIDUAL PROTECTIVE EQUIPMENT

This chapter is divided into four sections: (1) individual protection, (2) individual decontamination, (3) detection and alarms, and (4) patient protective equipment. For further information on items in this chapter, see the current technical manual for each piece of equipment as applicable.

Individual Protection

Standard "A" individual protective equipment (IPE) is issued to each soldier depending on their military occupational specialty. IPE consists of the following items:

- M40A1 Chemical Biological Field Protective Mask
- M42A2 Chemical Biological Combat Vehicle Protective Mask
- M45 Air Crew/Land Warrior Chem-Bio Mask System
- MCU-2A/P Protective Mask
- M50 Field Protective Joint Service General Purpose Mask (JSGPM)
- M51 Combat Vehicle JSGPM
- M53 Chemical-Biological Protective Mask
- Joint Service Lightweight Integrated Suit Technology (JSLIST)
- Chemical/Biological/Radiological/Nuclear Lightweight Overboots Alternative Footwear Solution (AFS)
- JSLIST Block 2 Glove Upgrade (JB2GU)

M40A1, M42A2, and M45 Masks

The M40A1, M42A2, and M45 masks (serial numbers TM 3-4240-346-10 and TM 3-4240-348-10) share many of the same design characteristics, capabilities, and features, but each was designed

for specific mission requirements such as aircraft or combat vehicle operation. These masks provide users with respiratory, eye, and face protection against chemical and biological agents and radioactive fallout particles. If a mask is properly fitted and worn correctly, it provides a gas-tight face seal, which prevents contaminated air from reaching the wearer's respiratory, ocular, and dermal systems.

These masks were not designed for use in toxic industrial chemical (TIC) environments and are known to be ineffective against some of these chemicals, such as ammonia and carbon monoxide. With these agents, the masks should be considered an escape device only, and personnel exposed to unidentified TICs should leave the contaminated area as rapidly as possible. The masks are also not suitable for confined spaces where oxygen is insufficient to support life.

Each mask is constructed of silicone rubber with an in-turned sealing surface so that it can form a comfortable seal on the wearer's face, providing an external "second skin" for additional protection. A key design feature is the use of a standard C2A1 NATO threaded filter canister. The canister is externally mounted and may be mounted on the left or right side of the face piece, depending on user preference. The C2A1 canister must be disposed of in accordance with state and local environmental laws.

A binocular eye lens system is used for improved vision, and clear and tinted outserts provide eye protection against laser and low speed fragmentation. Optical inserts may be used if the user requires corrective lenses. An elastic head harness secures the mask to the user's face. Other common features include front and side voicemitters to allow for face-to-face and phone communications. Each of the masks is furnished with drinking tubes to allow for hydration.

MCU-2A/P Protective Mask

The MCU-2A/P mask (Air Force Technical Order 14P4-15-1) is designed to protect the face, eyes, and respiratory tract from tactical concentrations of chemical and biological agents, toxins, and radioactive fallout particles. The mask has a unimolded silicone rubber face piece, and a single flexible lens bonded onto the face piece. The large lens gives the user a wide field of

vision. The mask has two voicemitters, one on the front of the mask for speaking directly into a telephone or radio handset and one at the side to allow communication with nearby personnel. The mask has a single filter. A nose cup with two inlet valves fits over the nose and mouth. It directs incoming air across the inside of the lens to reduce fogging. The mask has a drinking tube that connects to a canteen with an M1 cap. The mask is not authorized for use during TIC spills and is not effective against chemicals such as ammonia, chlorine, or carbon monoxide fumes. The mask is not effective in confined spaces where oxygen levels are insufficient to sustain life.

M50 and M51 Joint Service General Purpose Masks

The JSGPM (TM 3-4240-542-13&P) is the first joint service protective mask designed to replace the M40/M42 series of masks for the US Army and Marine Corps ground and combat vehicle operations, and the MCU-2/P series of masks for the Air Force and Navy shore-based and shipboard applications. The two models of this mask support major operational modes: the M50 for field use and the M51 for use in combat vehicles.

The M50 and M51 face-piece assemblies are built on a butyl/silicone rubber face blank with an inverted peripheral face seal and an integrated chin cup. The face-piece assembly forms a comfortable seal on the wearer's face and protects the face, eyes, and respiratory tract from chemical and biological agents, designated TICs, and radiological particulates. The face-piece assembly incorporates a flexible, single, polyurethane eye lens that provides an overall field of vision greater than 80%. A front module assembly provides a direct speech capability and integrates the exhalation disk valve, drinking system components, and communications interface. Filtration is provided by two filter mount assemblies (left and right) that integrate the air inlet disk valves and self-sealing disk valves, and a nose cup that controls the flow of air throughout the mask and keeps the wearer's breath from fogging the eye lens.

Both masks use twin M61 filters, positioned on either side of the face piece to provide protection against nuclear, biological, and chemical threats. The filters are attached to the filter mount using a twist-and-lock mechanism. The M51 uses the combat

vehicle hose assembly to connect the mask to the vehicle collective protection system. Additionally, a protective hood is provided for JSLIST type VII users to protect the head and neck from exposure to agents, because these suits lack a hood.

M53 Chemical-Biological Protective Mask

The M53 mask (TM 3-4240-541-12&P) is specially designed to meet US Special Operations requirements; it is not a standard mask issued to other service members. The M53 face-piece assembly is built on a butyl/silicone rubber face blank with an inverted peripheral face seal and an integrated chin cup. The face-piece assembly forms a comfortable seal on the wearer's face and protects the face, eyes, and respiratory tract from chemical and biological agents, certain TICs, and radiological particulates. The face-piece assembly includes the following elements:

- a single, flexible, polyurethane eye lens;
- a variable-resistance exhalation unit that allows for operations in various modes (negative pressure, powered air purifying respirator, self-contained breathing apparatus, and closed circuit breathing apparatus);
- drinking system components;
- a communications interface; and
- single-filter mount assemblies with a 40-mm NATO thread that integrate the inlet disk valve and air deflector.

The mask uses a single general purpose filter, positioned on the side of the face, to provide protection against nuclear, biological, and chemical threats and certain TICs. A particulate filter is also available as an additional authorization list item. A protective hood is provided for JSLIST type VII users.

Joint Service Lightweight Integrated Suit Technology

The JSLIST (TM 10-8415-220-10) consists of a two-piece garment system that provides protection from radiological, biological, toxin, and chemical contaminants. The system provides multiple improvements over legacy protective garments, including

reduced thermal burden, reduced weight, and increased wear time. The garment is assembled with a rip-stop outer shell of 50% nylon and 50% cotton poplin, and an interior liner of filter fabric that uses carbon sphere beads to reduce chemical and biological contamination. The garment is manufactured in two distinct designs: type II and type VII. Type II has a hood and is used for most applications; type VII has a stand-up collar and is used by Special Operations personnel. The JSLIST is currently available in desert, woodland, and universal camouflage.

JSLIST suits consist of a coat and trousers. Each component is separately packaged in a factory-sealed vacuum bag containing the ensemble item and a resealable bag. Once the garment has been removed from the vacuum-sealed packaging, it provides 45 days of wear time and 120 days of service life. Within the maximum wear time, the JSLIST provides up to 24 hours of protection against chemical and biological agents in solid, liquid, or vapor form. The garment will also protect against alpha and beta radioactive particles. To properly maintain and store the JSLIST when not in use, the garment should be placed in the resealable bag furnished with each component of the ensemble.

The JSLIST ensemble must be worn in all environments under threat of an imminent nuclear, biological, or chemical attack, or after chemical operations have been initiated. The garment can be laundered up to six times by field methods. However, once the garment has been contaminated, the soldier must replace it as soon as mission permits by using mission-oriented protective posture (MOPP) gear exchange procedures.

The JSLIST adds weight to the soldier's workload. In addition, the garment reduces heat exchange with the environment and may add, depending on the level of exertion, 10° to 15°F to the wearer's ambient temperature and heat burden. When wearing the JSLIST at MOPP 1 or MOPP 2 and complete encapsulation is not required, certain modifications to the uniform are authorized:

- Trouser leg Velcro (Velcro Industries, Manchester, NH) closures may be opened.
- Waist tabs may be loosened.
- Jacket may be unzipped.
- Sleeve Velcro closures may be opened.

This overall loosening of the JSLIST will allow heat to escape because walking and other movements induce a bellows action of the suit against underlying clothing and skin.

Alternative Footwear Solution

The AFS, issued with the JSLIST, is a chemical-biological protective overboot worn over normal combat footwear. The AFS provides 24 hours of protection in a chemically or biologically contaminated environment. The overboots can be worn for up to 376 hours of wear time over 45 days in an uncontaminated environment. The overboots have an antislip ridge tread pattern for improved traction, an antistatic surface, fully sealed and vulcanized seams, and three sets of buttons with a butyl rubber securing strap for each set. The adjustable securing strap is symmetrical and can be released from either side of the overboot. If the overboots are contaminated with petroleum, oil, or lubricants, they should be wiped off within 2 minutes and air dried. If contaminants remain on the overboots for more than 2 minutes, their protection may be degraded. In such instances, the overboots must be replaced as soon as possible.

Joint Service Lightweight Integrated Suit Technology Block 2 Glove Upgrade

The JB2GU provides 24 hours of protection from battlefield concentrations of all known chemical and biological agents for up to 30 days of wear. The glove provides enhanced tactility, dexterity, durability, and comfort over legacy systems and can be worn in all climates. These qualities satisfy a broader spectrum of ground, shipboard, and aviation requirements. The JB2GU comes in two variants: flame-resistant (FR) and non–flame-resistant (nFR). The FR variant combines a leather and Nomex (DuPont, Wilmington, DE) outer glove with an inner chemical protective liner, for use by aviators and combat vehicle crews. The nFR variant is a molded glove made from compounded butyl rubber and comes with a removable protective liner for sweat management. The nFR glove is primarily for ground forces.

Individual Decontamination

The preceding section provided an overview of the primary IPE items, which, when used correctly, will prevent contact with agent in typical battlefield concentrations. The problem of decontamination arises when soldiers become exposed to liquid agent despite the availability of protective masks and clothing. This section addresses two decontamination kits currently in the inventory: the Joint Service Personnel/Skin Decontamination System, also known as Reactive Skin Decontamination Lotion (RSDL), and the M295 Individual Equipment Decontamination Kit. The kits are fairly simple in design and function, and instructions for their use are easily committed to memory. Because of the potency of liquid nerve agents and the rapidly occurring tissue damage caused by vesicants, every soldier must be able to conduct an effective decontamination of all exposed skin without referring to the instructions printed on the kits.

Joint Service Personnel/Skin Decontamination System (Reactive Skin Decontamination Lotion)

The Joint Service Personnel/Skin Decontamination System, or RSDL (NSN 6505-01-507-5074 TM 3-6505-001-10), which is approved by the US Food and Drug Administration, is an individually carried skin decontamination kit. RSDL provides soldiers the ability to decontaminate the skin after exposure to chemical or biological warfare agents, in support of immediate and thorough personnel decontamination operations. The kit consists of decontaminants and applicators required to immediately reduce morbidity and mortality resulting from chemical (and some types of biological) warfare agent contamination. The applicators are preimpregnated with RSDL, a potassium solution dissolved in a special solvent and water that facilitates the reaction of decontamination between the potassium salt and the chemical agent. The lotion decontaminates the warfare agents HD, soman (GD), and VX as well as T-2 mycotoxins on skin to a level that eliminates toxic effects better than the previous M291 kit. It should be used on unbroken skin

only. Each packet will decontaminate an area of 1,300 cm^2. The system can be used in temperatures ranging from -25°F (-32°C) to 130°F (54°C). In addition to skin, it can be used to decontaminate individual equipment and weapons.

M295 Individual Equipment Decontamination Kit

The M295 (NSN 4230-01-357-8456; TM 3-4230-235-10) is a handheld kit used to apply decontaminant to an individual's personal equipment. Each kit consists of a carrying pouch that contains four sealed packets (enough to do two complete individual equipment decontamination operations). The packet is designed to fit comfortably within a pocket of the JSLIST overgarment trousers. Each individual M295 contains one mitt comprised of 22 g of decontaminating powder contained within a pad material and a polyethylene film backing. In use, powder from the mitt is allowed to flow freely through the pad material. Decontamination is accomplished through sorption of contamination by both the pad and the decontaminating powder. The M295 is issued in boxes of 20. The kits should be stored at the squad level in a box capable of being decontaminated.

Detection and Alarms

This section describes the equipment issued for detection and identification of chemical agent liquid and vapor in the environment. For both the individual soldier and the unit, these items (listed below) are the primary means of detecting the presence and identifying type of chemicals on the battlefield, and determining when a safe condition exists:

- M9 Chemical Agent Detector Paper
- M8 Chemical Agent Detector Paper
- M256A1 Chemical Agent Detector Kit
- Improved Chemical Agent Monitor (ICAM)
- M4A1 Joint Chemical Agent Detector (JCAD)
- M272 Chemical Agent Water Testing Kit
- M22 Automatic Chemical Agent Detection Alarm (ACADA)

M9 Chemical Agent Detector Paper

M9 detector paper (NSN 6665010498982; TM 3-6665-311-10) is placed on personnel and equipment to detect and identify the presence of liquid nerve or blister agents in exposures as small as 100 μ in diameter. The paper contains an indicator chemical dye that turns pink, red, reddish brown, or red purple when exposed to liquid agents. It is capable of detecting chemical agents but cannot identify specific agents. M9 paper is manufactured in 30 ft × 2 in. adhesive-backed rolls of matte cream-colored paper. The rolls are packaged with a reusable plastic storage bag in a vacuum-sealed vapor-barrier package. The paper's dye is a potential carcinogen, so chemical protective gloves should be worn when handling it. Placement of M9 paper is dictated by the user's dominant hand: if the user is right-handed, the paper should be placed around the right upper arm, left wrist, and right ankle. Left-handed users should place the paper around the left upper arm, right wrist, and left ankle. If a color change occurs, proper masking, decontamination, and MOPP procedures must be followed.

Many substances are known to cause false positive responses on M9 paper, including antifreeze, liquid insecticide, and petroleum products (but this does not relieve service members from the obligation to mask and take other appropriate measures). Attention to possible substances that might affect the paper on the battlefield can help in the later interpretation of a color change in the absence of confirmation tests for agents.

M8 Chemical Agent Detector Paper

M8 paper (NSN 6665000508529) is used to detect the presence of liquid V-type nerve, G-type nerve, and H-type blister agents. M8 paper is issued in staple-bound booklets containing 25 tan-colored sheets of chemically treated, dye-impregnated paper. Each page is perforated for easy removal. If M8 paper is exposed to chemical agents, its color will convert from tan to an agent-specific color, depending on the agent. The reverse side of the front cover contains a bar chart for color comparison agent recognition. The following agents will cause the dye to change to one of three colors:

- G (nonpersistent nerve agent): yellow
- H (blister agent): red
- V (persistent nerve agent): olive green or black

If the M8 paper reacts, or a liquid is suspected of being a chemical agent, service members must follow proper masking, decontamination, and MOPP procedures. To prepare M8 paper to conduct agent identification, tear one half sheet from the booklet, and affix it to a stick or other object. Using the stick as a handle, blot the paper onto the unknown liquid, and wait 30 seconds. Once this time has elapsed, compare the tested M8 paper to the color comparison bar chart inside the booklet's front cover.

The following are common causes of false positive indicators: antifreeze, liquid insecticide, and petroleum products. Attention to such substances on the battlefield can help in the later interpretation of a color change on the M8 paper.

M256A1 Chemical Agent Detector Kit

The M256A1 kit (NSN 6665011334964; TM 3666530710), designed to detect and identify chemical agents in liquid or vapor form, consists of the following:

- a booklet of M8 paper (described above) to detect agents in liquid form, and
- twelve foil-wrapped detector tickets containing eel enzymes as reagents to detect very low concentrations of chemical vapors.

Instructions for the use of the detector tickets appear on the outside of each of the foil packets and in a separate instruction booklet in the kit. Table 11-1 shows the agents detected by the M256A1 kit.

By following the directions on the foil packets or in the instruction booklet, service members can conduct a complete test with the liquid-sensitive M8 paper and the vapor-sensitive detector ticket in approximately 20 minutes. During the test, the sampler must be kept out of direct sunlight, which speeds

Table 11-1. Agents Detected by the M256A1 Chemical Agent Detector Kit

Agent	Symbol	Class
Hydrogen cyanide	AC	blood (cyanide)
Cyanogen chloride	CK	blood (cyanide)
Mustard	H	blister
Nitrogen mustard	HN	blister
Distilled mustard	HD	blister
Phosgene oxime	CX	blister
Lewisite	L	blister
Nerve agents	V and G series	nerve

evaporation of the reagents. Waving the detector sampler in the air also accelerates evaporation, so the sampler should be held stationary during all parts of the test.

Improved Chemical Agent Monitor

The ICAM (NSN 6665-01-357-8502; TM 36665343-10; Figure 11-1), which is used to detect nerve and blister agents as vapors only, uses a 10-mCi nickel 63 β-particle radiation source to ionize airborne agent molecules that have been drawn into the unit by a pump. The resulting ion clusters vary in mass and charge and thus also travel at different rates in an applied electrical field. Comparing the mobility of the different ionic species to electronically stored standards allows an on-board microcomputer to determine the type of agent and its relative concentration. A liquid crystal display presents these data as a series of concentration-dependent bars in a G mode for G agents and VX, and in an H mode for blister agents.

The ICAM detects agent vapor in the volume of air drawn by the pump into the sampling chamber. Therefore the inlet port must not come into contact with a suspected area of evaporating agent on a surface, but must be placed within a few inches of the suspected contamination site. Because of the variation in agent concentration from one spot to another, depending upon wind

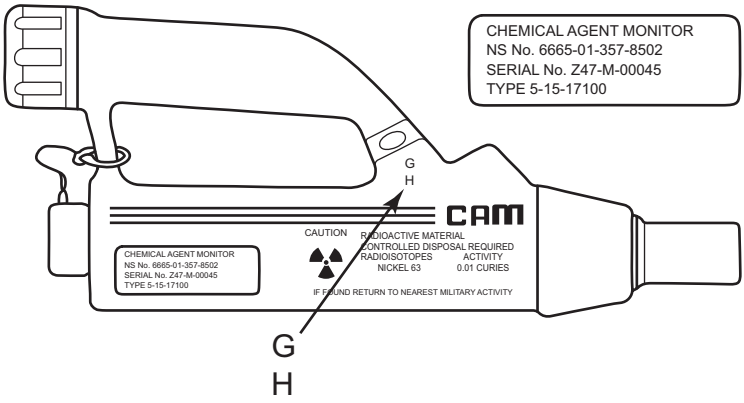

Figure 11-1. Improved Chemical Agent Monitor (ICAM). Used to detect nerve and blister agents as vapors only, the ICAM uses a 10-mCi nickel 63 β-particle radiation source to ionize airborne agent molecules that have been drawn into the unit by a pump. The resulting ion clusters vary in mass and charge and thus also travel at different rates in an applied electrical field. Comparison of the mobility of the different ionic species to electronically stored standards allows an on-board microcomputer to determine the type of agent and its relative concentration. A liquid crystal display presents these data as a series of concentration-dependent bars in a G mode for G agents and VX, and in an H mode for blister agents.

velocity and other environmental factors, numerical displays of agent concentration in typical units would be impractical and unreliable. Accordingly, the display warns of a low vapor hazard (1 to 3 bars visible), a high vapor hazard (4 to 6 bars visible), or a very high vapor hazard (7 to 8 bars visible).

M4A1 Joint Chemical Agent Detector

The JCAD (NSN 6665-01-586-8286; TM 3-6665-456-10) is a stand-alone, hand-held device that automatically detects, identifies, and alerts operators to the presence of agent vapors, including:

- the nerve agents tabun (GA), sarin (GB), soman (GD), GF, and VX;

- the blister agents mustard (H), nitrogen mustard (HN3), and lewisite (L);
- the blood agent hydrogen cyanide (AC); and
- the TIC cyanogen chloride (CK).

The JCAD is modified from a commercially available device. The JCAD is capable of supporting the mission requirements of all four services, including:

- interior detection in both tracked and wheeled vehicles;
- interior detection in fixed- and rotary-wing aircraft during both ground and airborne operations;
- interior and exterior shipboard detection;
- fixed-site chemical agent detection;
- personal detection, carried by an individual soldier or used for advanced perimeter warning; and
- surveys of personnel, equipment, and cargo.

The JCAD is carried by personnel and placed onto various platforms, including ground vehicles, fixed-site installations, and collective protection shelters. The JCAD can also interface with the Joint Warning and Reporting Network (a computer-based application that integrates sensor information into intelligence systems), allowing it to be used as a networked fixed-site detector without direct operator contact. Up to ten JCADs can be connected at distances up to 400 m apart. The base unit functions as a control unit providing chemical alerts and malfunction signals for the other nine units. Operating the JCAD in enclosed spaces or when sampling near strong vapor sources of the following will sound a false alarm:

- aromatic vapors (aftershave, perfume, food flavorings, peppermint);
- cleaning compounds (disinfectant, menthol, methyl salicylate);
- smoke and fumes;
- gun oil;
- diesel exhaust, JP-8 (jet fuel) vapor;
- small arms lubricant;

- cigarette smoke;
- paint fumes; and
- chemical-agent–resistant compound.

M22 Alarm

The M22 ACADA (NSN 6665-01-438-6963; TM 3-6665-321-12&P; Figure 11-2) is an automatic agent alarm system capable of detecting and identifying standard blister and nerve agents. The system is portable (can be carried by one person), operates independently after system start-up, produces an audible and visual alarm, and provides an automatic battlefield warning. The system consists of the M88 detector, as many as five M42 alarm units, a confidence sample, protective caps, a square inlet, rain caps, a carrying case, and various power supplies.

The M22 ACADA samples the air for the presence of nerve agent vapors (GA, GB, GD) and blister agent vapors (HD, L), and provides simultaneous detection and warning of these agents. It operates in cold and hot climates (-30°F to 125°F). The M88 detectors normally are placed facing into the wind no more than 150 m outside of the unit perimeter, with no more than 300 m between detectors. They are connected to the alarm units with WD-1/TT telephone wire. Whenever possible, the distance between the detector units and the alarm units should not exceed 400 m.

The following items can interfere with the normal operation of the M22 ACADA and will sound a false alarm:

- CS tear gas,
- JP-8 jet fuel,
- brake fluid,
- aqueous fire fighting foam, and
- M18 marking grenades (red and violet).

M272 Water Testing Kit

The M272 kit (NSN 6665011340885; TM 3666531910) was designed and fielded to answer the need for a test to detect water contamination by nerve agent, blister agent, cyanide (a blood agent), or lewisite. The kit operates at temperatures between 32°F and 125°F. An enclosed instruction card enables a soldier

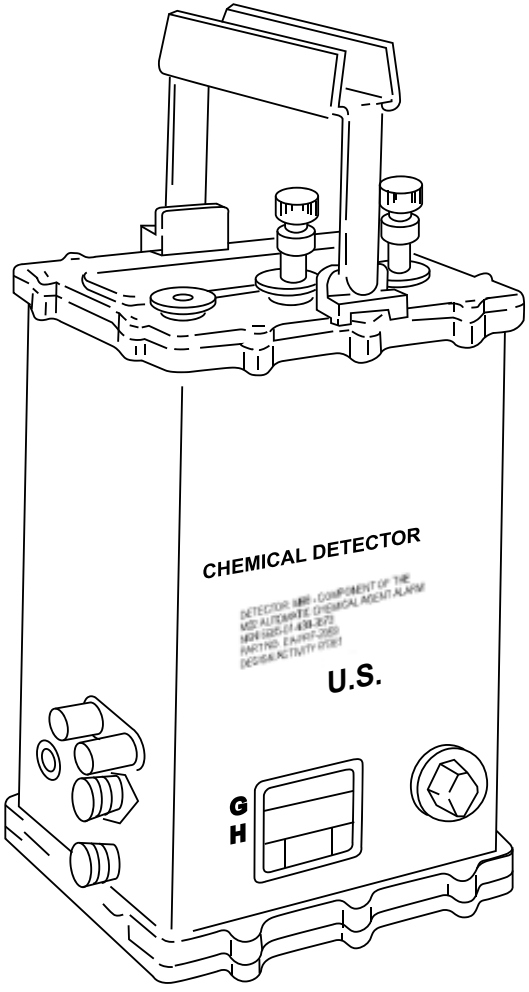

Figure 11-2. The M22 Automatic Chemical Agent Alarm (ACADA), which is capable of detecting and identifying standard blister and nerve agents. The system can be carried by a soldier, operates independently after system start-up, and provides an audible and visual alarm. It also provides communications interface for automatic battlefield warning. The system consists of the M88 detector, as many as five M42 alarm units, a confidence sample, protective caps, square inlet, rain caps, a carrying case, and various power supplies.

Table 11-2. Concentrations of Chemical Agents Detectable by the M272 Chemical Agent Water Testing Kit

Agent	Symbol	Concentration (mg/L)*
Cyanide	AC	20.0 as CN-
Mustard	HD	2.0
Lewisite	L	2.0 as As+++
Nerve agents	G, V	0.02

*Concentration reliably detected by kit tests. CN- is the liquid form of cyanide measurable in water.
As+++ is a form of arsenic, the positive elemental ion arsenous, which is measurable in water.

to conduct all the tests required to identify the threat agents. The kit will detect chemical agents at the concentrations listed in Table 11-2. Water containing agents in concentrations less than those detectable by the kit is permissible for short-term use (up to 7 days) in both cold and warm regions, as long as the daily consumption per person does not exceed 5 quarts.

Each kit contains enough reagents for tests on 25 separate water samples. The operator can easily conduct the full range of tests in 20 minutes when the temperature is between 50°F and 105°F; at lower temperatures, the water samples and the nerve agent ticket should both be warmed for 10 minutes before testing begins. At higher temperatures, between 105°F and 125°F, water should be cooled for at least 5 minutes to reduce its temperature to 105°F or cooler, because water that is too hot may cause foaming in the detector tubes for lewisite, mustard, and cyanide.

Patient Protective Equipment

This section discusses the patient protective wrap, decontaminable litters, and the Resuscitation Device, Individual Chemical (RDIC).

Patient Protective Wrap Kit

The patient protective wrap (NSN 6545-01-577-1047) was developed because decontamination and medical treatment of chemical casualties often requires removing clothing and

precludes donning replacement JSLIST garments. The wrap is used to protect patients from exposure to harmful chemical and biological materials for up to 6 continuous hours (patients should not be left in the wrap longer than this). When used in conjunction with the consumable items listed below, it prevents uncontaminated patients from potential contamination during evacuation. The patient protective wrap kit consists of the following consumable items:

- lightweight motor blower tester for the M48 mask (NSN 4240-01-497-5068)
- M96 Chemical-Biological Air Filter Cartridge (NSN 4240-01-574-9568)
- nonmetallic hose (NSN 4720-01-577-5616)
- protective dust cap (NSN 5340-01-577-5631)
- battery charger (NSN 6130-01-577-5620)
- rechargeable battery (NSN 6140-01-500-9672)
- patient wrap blower (NSN 6530-01-543-7916)
- patient litter wrap (NSN 6530-01-577-1091)
- airflow indicator (NSN 6640-01-500-7721)

The wrap resembles a lightweight sleeping bag; it measures 107 cm wide by 249 cm long and weighs 2.7 kg. It is constructed of a permeable sheet of carbon-impregnated fabric and an impermeable bottom sheet. The top sheet has an impermeable, transparent window to permit observation of the patient during transit. A port to provide a protective entryway for the insertion of intravenous tubing is located at each side of the window. The blower is a small, lightweight unit providing a continuous flow of clean, filtered air for breathing. Using the blower considerably reduces the danger of heat stress on the casualty, and increases the wrap's operational effectiveness in hot climates.

Decontaminable Litter

Contaminated casualties arriving at a medical treatment location will in most cases require decontamination prior to definitive treatment. The decontamination process requires the use of equipment organic to the treatment unit. Ideally, equipment in

limited supply should be capable of complete decontamination using methods available in the field.

The decontaminable litter (NSN 6530-01-290-9964) is made from a monofilament polypropylene with high tensile strength and low elasticity. The fabric does not absorb liquid chemical agents and is not degraded by decontaminating solutions. The fabric is flame retardant, highly rip resistant, and treated to withstand exposure to weather and sunlight. The fabric has a honeycomb weave, which results in a rough, non-slip surface, and liquids easily pass through the open 40% of the surface area. The carrying handles retract into the metal pole frame for a closed total length of 83.5 in. (212.1 cm) to allow for loading the litter onto the UH60 helicopter. The handles have two open positions, at 90.0 in. (228.1 cm) and 91.6 in. (232.7 cm). The first position is a NATO standard. The second position is provided to allow increased gripping comfort. The aluminum poles have been also designed to provide direct gripping surfaces for litter stanchions. All metal parts have been painted with chemical-agent–resistant coating paint.

NOTE: *Canvas litters exposed to liquid blister agents and then decontaminated still desorb vapors for 72 hours.*

Resuscitation Device, Individual Chemical

The RDIC (NSN 6515-01-338-6602) is used in a contaminated environment to ventilate casualties. It consists of a compressible butyl rubber bag, a NATO standard C2A1 canister filter, a non-rebreathing valve, a cricothyroid cannula adapter, and a flexible hose connected to an oropharyngeal mask. The mask is removable from the distal end of the flexible hose for connection of the hose to the cannula adapter. The butyl rubber bag resists penetration by liquid chemical agent that may be on the chemical protective gloves of the operator, and is easily decontaminated. The elasticity of the outer cover limits airway pressure to a maximal value of 70 cm H_2O. The device can deliver up to 600 mL of filtered air per cycle at a rate of 30 cycles per minute. At a patient decontamination station, the RDIC is commonly used in the emergency medical treatment area.

Chapter 12

MILITARY WORKING DOGS IN CONTAMINATED ENVIRONMENTS

This chapter is adapted from: Headquarters, Department of the Army. *Veterinary Service Tactics, Techniques, and Procedures.* Washington, DC: HQDA; December 2004. FM 4-02.18.

Introduction

This chapter is intended for military working dog (MWD) handlers, veterinary personnel, and nonveterinary healthcare providers who may encounter MWDs that have chemical, biological, radiological, or nuclear (CBRN) injuries. The majority of information for human CBRN casualties, CBRN protection, and decontamination can generally be applied to all animals; however, some signs and symptoms associated with human chemical or biological exposure may not present in animals, making it harder to recognize the severity of the injuries or illness.

Information on CBRN exposures in MWDs can also be found in the US Army Office of the Surgeon General's brochure *The Military Working Dog Handler's Guide for the Use of Medical Chemical, Biological, Radiological and Nuclear Defense Materiel* (NSN 7610-01-564-2341). Initial issue guidelines for MWD medical CBRN defense materiel (MCDM) can be found in *Army Medical Department Supply Information* (Department of the Army Supply Bulletin 8-75-S7, 20 July 2013).

Currently, protection of MWDs in a CBRN environment is difficult. Although no CBRN protective equipment for MWDs exists in the inventory and CBRN doctrine for animals is incomplete, both equipment and doctrine for MWDs are under development. The information below on protective

measures applies particularly to the MWD but can be used with other animals. After discussing measures to protect dogs and equipment from all agents, this chapter will describe specific agents, signs and symptoms of exposure to each of them, and treatment for exposed MWDs.

Protective Measures

Providing dogs with CBRN protection decreases or eliminates the amount of decontamination and treatment needed after an exposure. Ideally, MWDs would not require decontamination or treatment. However, in the absence of MWD-specific protective equipment or shelters, protecting dogs is difficult if they cannot be placed in an available shelter. If a CBRN attack is likely, the only reliable method of MWD protection is removal from the area. For immediate field-expedient protection, the MWD can be covered with wet weather gear, a tarp, or similar impervious materials, which will provide some protection while the MWD is evacuated from the area.

If an MWD must remain on site, limited protection may be provided by:

- Placing the MWD in a collective protection shelter with the handler. This is the preferred method.
- Moving the MWD into an existing structure or vehicle that has been sealed with tape, tarps, or tentage to prevent inflow of contaminated air. **NOTE:** The risk of heat injury to an MWD in a sealed vehicle may be higher than the risk of a chemical or biological injury during a potential attack.
- Placing the MWD into a transportable kennel covered with tarps, tentage, or plastic to limit contamination by droplet or liquid agent.
- If the dog must walk through a contaminated area, decontaminating its paws and then placing chemical-impervious barriers on the paws. Ideally, the MWD should not be walked through any area with ground contamination, but if it's necessary, the following items may provide limited protection if placed over the paws and taped at the carpus or tarsus:

- Mylar (DuPont, Wilmington, DE; polyethylene terephthalate) specimen bags,
- outer bag from an MRE (meal, ready-to-eat),
- extra butyl-rubber protective gloves or Joint Service Lightweight Integrated Suit Technology gloves, or
- tape or canvas over wrap on the surface of the paws that contact the ground.

Kennel Facility Protection

In the absence of specific MWD kennel collective protection shelters, the principles of field expedient protection covered in *Multiservice Tactics, Techniques, and Procedures for Nuclear, Biological, and Chemical (NBC) Protection* (Washington, DC: US Army, Marine Corps, Navy, Air Force; 31 December 2009; FM 3-11.4/MCWP 3-37.2/NTTP 3-11.27/AFTTP (I) 3-2.46) should be followed. MWDs should be housed in chemical-biological protective shelters or joint expeditionary collective protection shelters, if available.

Protection of Military Working Dog Rations and Equipment

Bagged MWD food and equipment (such as leather leashes and collars and leather or plastic muzzles) are subject to contamination and may be difficult to decontaminate. One set of MWD handling equipment and a short-term supply (1–4 weeks) of food for each dog should be stored in an impervious and easily decontaminated container. Tightly sealed plastic cans (NSN 7240-01-094-4305) may be used for these items and stored in a nearby chemical protective shelter or protected vehicle.

Pretreatment of Military Working Dogs

The Department of Defense Military Working Dog Veterinary Service, a subordinate unit of the US Army Public Health Command, does not recommend the use of soman nerve agent pyridostigmine pretreatment (SNAPP) in MWDs because its effect on a dog's detection performance has not been evaluated. SNAPP will only be issued when expressly authorized by the Army Office of the Surgeon General, and its use must also be authorized by a veterinarian and

the MWD unit commander. When its use is authorized, the recommended SNAPP regimen is a half tablet (15 mg) every 8 to 12 hours. Follow precautions regarding SNAPP in *Multiservice Tactics, Techniques, and Procedures for Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries* (Washington, DC: US Army, Marine Corps, Navy, Air Force; September 2007; FM 4-02.285/ MCRP 4-11.1A/NTRP 4-02.22/AFTTP (I) 3-2.69).

Before an MWD goes on duty, its handler must evaluate the dog's ability to perform assigned tasks, taking into consideration whether it has received SNAPP. Any MWDs under the influence of the SNAPP must be identified prior to entry into a contaminated environment.

Nerve Agents

- Agents include tabun (GA), sarin (GB), soman (GD), GF, and VX.
- Clinical signs of mild exposure include unexplained runny nose, unexplained tearing, excessive salivation (drooling), pinpoint pupils, heavy panting, and muscle twitching.
- Clinical signs of severe exposure include severely pinpointed pupils; red eyes with excessive tearing; coughing, difficulty breathing; urination, defecation, vomiting; severe muscle twitching; convulsions; and loss of consciousness.
- Decontamination: for dogs, use Reactive Skin Decontamination Lotion (RSDL) and large amounts of soap and water; for MWD equipment, use the M295 Individual Equipment Decontamination Kit (IEDK) and 5% hypochlorite (bleach).
- Immediate management for mild exposure: administer two Antidote Treatment Nerve Agent Autoinjector (ATNAAs).
- Immediate management for severe exposure: administer three ATNAAs, three atropine autoinjectors, and one Convulsive Antidote, Nerve Agent (CANA; diazepam).

Absorption

Nerve agents dispersed by aerosol, vapor, or spray can be absorbed through a dog's respiratory tract, eyes, mouth, gastrointestinal tract, and skin. Respiratory absorption is the greatest concern because of the speed of absorption and

toxicity. Absorption of nerve agent through the mouth may occur simultaneously with respiratory exposure. However, oral and gastrointestinal absorption is of greater concern when a dog ingests nerve agent by eating contaminated food, drinking contaminated water, or licking its contaminated paws or hair. Because of the combination of hair and lack of sweat glands, the risk of nerve agent absorption through the skin is of less concern in dogs than in people; however, the risk is still significant. Absorption through the paws is the greatest concern for dermal absorption because a dog's footpads have sweat glands and no hair.

Effects on Food and Water

Liquid nerve agents or vapors of nerve agents can contaminate food and water. MWDs should not drink from water holes or trenches in contaminated areas or drink surface water that has run off from contaminated areas. Water suspected of being contaminated should be tested by preventive medicine or public health personnel, and only water found to be safe should be used for consumption. Contaminated food or food that is suspected of being contaminated should not be fed to MWDs unless approved by veterinary personnel. Food and water packaged in sealed, airtight cans, bottles, or other impermeable containers can be decontaminated according to procedures in *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Decontamination* (Washington, DC: US Army, Marine Corps, Navy, Air Force; April 2006; FM 3-11.5/MCWP 3-37.3/NTTP 3-11.26/AFTTP (I) 3-2.60).

Clinical Signs

Nerve agents generally produce similar effects, although the onset and severity of signs may vary depending upon the route and degree of exposure.

Eyes. Exposure to nerve agent vapors produces local ocular and respiratory effects before other effects. These signs usually appear within 5 minutes of exposure. The initial ocular effect is pinpoint pupils (miosis). More severe exposures may cause eye pain and visual impairment.

Respiratory tract. Respiratory exposure is manifested by rapid, heavy panting and an increase in upper respiratory secretions resulting in watery nasal discharge. Increased upper respiratory secretions with bronchoconstriction will cause coughing, rattling sounds in the throat, wheezing, and respiratory distress.

Systemic. Systemic absorption of enough nerve agent through the respiratory or gastrointestinal system will increase the severity of local effects and also cause generalized systemic effects. Respiratory distress becomes marked as a result of profuse bronchial secretions, bronchoconstriction, and airway obstruction. The distressed animal will gasp, and the mucous membranes of its mouth will become blue (cyanotic) as a result of decreased oxygenation. Other effects that may occur are slowing of the heart rate, profuse salivation and frothing, loss of fecal and urinary control, defecation, vomiting, and abdominal pain. Muscular effects also occur, including weakness, twitching, and trembling. As weakness and paralysis of the respiratory muscles progress, breathing becomes increasingly labored, shallow, rapid, and finally intermittent, and the animal quickly becomes oxygen deficient.

In severe exposures, the onset and progression of signs are very rapid. The animal may tremble violently, become uncoordinated, collapse, and go into generalized convulsive seizures. Loss of consciousness may ensue with a total loss of reflexes. Convulsions may become intermittent, with the animal showing a rapid panting respiration between convulsive episodes. Marked generalized convulsions are usually followed by complete flaccid paralysis, central respiratory and circulatory depression, asphyxiation, and death.

Skin. The signs of cutaneous exposure to liquid nerve agents are similar to respiratory exposure to nerve agent vapors. One difference is that the initial signs take longer to develop and the transition from mild to severe signs may be slower. In fatal cases of skin exposure, the survival period may last hours, whereas in inhalation exposure most deaths occur in a few minutes. Cutaneous exposure causes local twitching at the site of contamination, increased gastrointestinal activity, salivation, pinpoint pupils (miosis), generalized tremors, prostration, and convulsions. In contrast to inhalation exposure, dyspnea is not a

pronounced sign of early cutaneous exposure. Decreased mental activity occurs during the prolonged convulsive phase. A lethal factor in cutaneous exposure is the rapid and very considerable rise in body temperature to heatstroke levels caused by the prolonged convulsions.

Decontamination

For MWD nerve agent decontamination, use RSDL, large amounts of soap and warm water, or both. MWD equipment can be decontaminated using an M295 IEDK or 5% hypochlorite (bleach).

Initial Treatment

The initial MCDM issue for nerve agent treatment is three ATNAAs, five additional atropine autoinjectors, and four CANAs. **NOTE:** Keep used autoinjectors with the dog during evacuation.

Initial treatment by the MWD handler depends on the severity of nerve agent exposure. For mild MWD nerve agent exposure, administer two ATNAAs into the back of the dog's thigh. This initial dosage of two ATNAAs includes 4 mg of atropine and 1,200 mg of pralidoxime chloride (2-PAM Cl). CAUTION: MWDs should not need additional 2-PAM Cl injections. For severe MWD nerve agent exposure, administer three ATNAAs, three atropine autoinjectors, and one CANA (diazepam) autoinjector into the back of the thighs of the dog (Figure 12-1). This is similar to the buddy aid provided by one soldier to another suffering from severe nerve agent poisoning.

Follow-Up Treatment for Severe Nerve Agent Exposure

1. Single atropine autoinjectors may be given every 10 to 20 minutes until the nerve agent effects have subsided or signs of atropinization appear (this is equivalent to combat lifesaver aid for soldiers with severe nerve agent poisoning).

   Signs of *effective* atropinization include dry mouth and mucous membranes, increased heart rate, and increased body temperature. Signs of *excessive* atropinization and

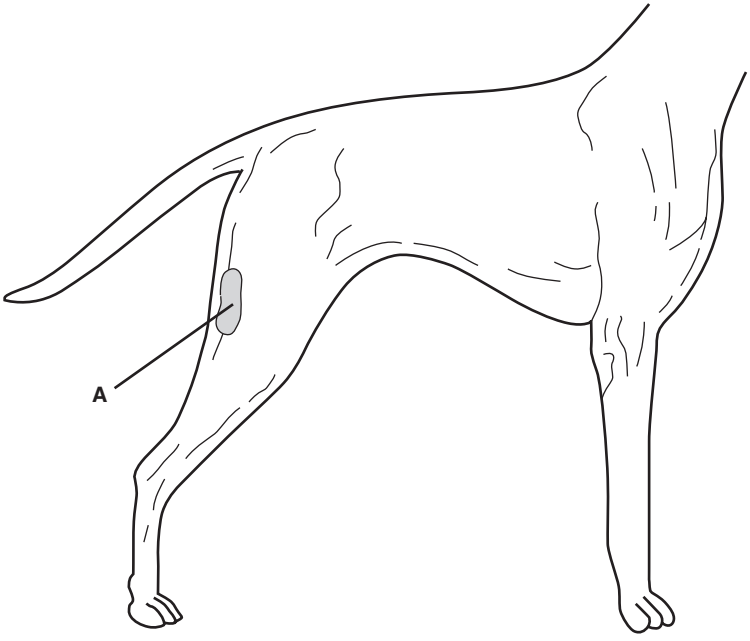

Figure 12-1. Location (A) for administering emergency treatment for severe nerve agent exposure in military working dogs.

atropine toxicity may include vomiting, thirst, difficulty eating, constipation, difficulty urinating, altered mental status (either depression or excessive stimulation), ataxia, seizures, decreased respiration rate, increased heart rate with possible arrhythmias, and abnormal blood pressure (decreased, with shock and circulatory collapse, or increased).

Atropine administered systemically may not overcome local ocular effects, so the absence of pupillary dilation does not necessarily indicate the need for further atropine administration.

Canine nerve agent casualties can tolerate much greater doses of atropine than would a normal (unexposed) dog. However, repeated doses of atropine will markedly increase its effects, especially in animals that have received only a

minimal exposure. The MWD must be monitored for heat stress because atropine dries the mucous membranes, thus preventing the dog from expelling body heat.

2. If the dog is still showing signs of seizures after initial treatment, it may be given up to three additional CANA autoinjections at 5 to 10 minute intervals until seizures stop.
3. Maintain a clear airway by removing respiratory secretions and saliva that may obstruct the airway. Loosen or remove the muzzle. **CAUTION:** When clearing the MWD's airway, be careful to avoid being bitten. Even a minor MWD bite could compromise mission-oriented protective posture (MOPP) equipment, resulting in human nerve agent exposure.
4. In severe nerve agent exposure, the animal's respiration is markedly depressed, and extreme muscular weakness or paralysis is present. In such cases, assisted ventilation is required to effectively resuscitate the animal.
5. Adequate atropine and 2-PAM Cl should bring about an improvement or restoration of spontaneous respiration and also improve blood circulation. If signs of nerve agent exposure persist or recur, veterinary personnel may need to administer additional 2-PAM Cl autoinjectors every 8 to 12 hours for up to 3 days.

   NOTE: Atropine is usually sufficient to control central nervous system (CNS) signs. If convulsions persist or occur intermittently and further interfere with respiration, they may be controlled by the administration of CANA.

Vesicants (Blister Agents)

- Vesicants include sulfur mustard (H/HD), nitrogen mustard (HN), lewisite (L), and a mixture of mustard and lewisite (HL).
- Clinical signs (HD and HN) exposure include an asymptomatic latent period (hours), after which the following signs may appear:
  - skin: redness, blisters, ulcerations
  - eyes: irritation, conjunctivitis, swollen eyelids, corneal opacity, corneal ulcerations
  - respiratory: cough, nasal discharge, difficulty breathing, fever, tracheal and pulmonary rales

  - gastrointestinal: oral ulceration, abdominal pain, vomiting, bloody diarrhea
  - systemic: excitation, salivation, slowed heart rate, decreased white blood cell and platelet counts, shock
- Fever is not typically associated with these agents.
- Signs of lewisite exposure include immediate pain, restlessness, vomiting, bloody diarrhea, shock, weakness, anemia, and pulmonary edema.
- Decontamination of MWDs: use large amounts of soap and water. RSDL should be used for HD only. For MWD equipment, use an M295 IEDK and 5% hypochlorite (bleach).
- Immediate management: symptomatic and supportive care.

When applied to MWDs, the terms "blister agent" and "vesicant" are misnomers because vesiculation (blistering) generally does not occur in dogs or most other animal species. Despite the lack of blistering, these agents cause injury to any part of the dog's body they contact. If the MWD must transit a contaminated area, MWD CBRN protection recommendations should be followed.

Distilled Mustard Absorption

Distilled mustard (HD) is used as a delayed-action casualty agent. Its persistency depends upon the munitions used and the weather. With an increase in temperature (over 90°F) and humidity, there is a marked decrease in the effective dosage. Although HD is not persistent at high temperatures (100°F –120°F), mustard vapor becomes a major hazard. In addition, wet skin absorbs more mustard agent than does dry skin.

Clinical Signs

Liquid mustard or mustard vapors produce delayed effects on the skin and eyes following exposure. The long hair of dogs does not prevent injury to the skin, but it does impede the penetration of liquids and vapors.

Skin. Contamination of the skin is followed by a latent period, which varies in length with the degree of exposure. Within 1 hour after exposure, piloerection (erection of the hair) occurs at

the site of exposure and may last for an hour or more. Two to three hours after that, redness and edema of the skin develop, increasing in intensity for 24 hours and then subsiding. In mild exposures, edema is followed by exfoliation of the epidermis of the skin. Severe exposures cause ulcerated lesions. The lesions heal if secondary infection can be prevented or treated adequately. **NOTE:** The skin of the abdomen, axilla, face, and feet are more susceptible to damage from HD than other parts of the skin, and this sensitivity is not directly related to the length of hair protecting the rest of the dog's body.

Eyes. The eye is the body part most sensitive to mustard's corrosive effects. Liquid mustard or heavy vapor exposures can be extremely damaging to the eye. Mild ocular exposures are followed by conjunctivitis and conjunctival edema, usually appearing within 1 or 2 hours; edema of the eyelids; corneal opacity and inflammation of the cornea; corneal roughening; and pain. More severe exposures can produce more serious lesions, resulting in necrotic conjunctivitis, corneal erosions or deep ulcerations, deep ophthalmic inflammation, and permanent corneal opacification due to scarring. These lesions predispose the eye to secondary bacterial infections.

Respiratory tract. Mild to severe exposures to mustard vapor may damage the respiratory tract. Inhalation of blister agent vapors will initially produce sloughing and ulceration of the tracheobronchial mucosa. Profuse inflammatory exudation and edema may cause respiratory distress. Severe exposures affect the lung tissue, causing pulmonary edema and acute pulmonary alveolar emphysema, which may become complicated by secondary purulent bronchopneumonia. The effects of respiratory exposures tend to develop over several days. The signs of respiratory involvement include cough, nasal discharge, respiratory difficulty, fever, and tracheal and pulmonary rales.

Gastrointestinal tract. Ingesting contaminated food and water or licking contaminated body areas may produce ulceration of the mucous membranes, resulting in oral ulceration, abdominal pain, vomiting, bloody diarrhea, and prostration.

Systemic. Systemic absorption of mustard can result from extremely high skin or respiratory exposures, or absorption of the agent in the intestines. It may produce systemic effects

involving the CNS, cardiovascular system, and hematopoietic system. The possibility of severe leukopenia and susceptibility to infection also exists. These effects are manifested by excitation, salivation, slowed heart rate, decreased count of white blood cells and platelets, bloody diarrhea, and shock.

Decontamination

MWD decontamination for distilled mustards involves large amounts of soap and warm water and RSDL (for HD only); MWD equipment can be decontaminated using an M295 IEDK or 5% hypochlorite (bleach). Keep in mind the following considerations:

- Decontamination should be carried out within 2 minutes after contamination with vesicants to prevent injury. Before redness and edema appear, localized areas can be decontaminated by using the RSDL (for HD only) as described in *Multiservice Tactics, Techniques, and Procedures for Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries* or washing the MWD with soap and warm water.
- Do not use RSDL in or around the eyes as it may cause additional ocular injury. The eyes must be decontaminated with copious water irrigation immediately after exposure. Ophthalmic ointments should not be applied until after thorough decontamination is completed and the eyes have been examined, because ointments may absorb mustard agents and prolong corneal exposure, thus increasing eye injury.

Treatment

Treatment for either local or systemic effects of blister agents is primarily symptomatic and similar to the treatment described in *Multiservice Tactics, Techniques, and Procedures for Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries* for human casualties. Specific systemic or topical antibiotic therapy should be administered when indicated. Supportive therapy may be required to maintain the animal's nutritive and fluid status. With eye injuries, the degree of corneal damage should be determined with fluorescein stain and treated

accordingly with an antibiotic or a combination of antibiotics and steroid ointments. The possibility of leukopenia, lung damage, sepsis, or others injuries may also exist.

Nitrogen Mustards

Nitrogen mustard (HN) is a delayed-action agent; it may be hours or longer before a dog feels skin-damaging symptoms. A dog's eyes are very susceptible to low concentrations of HN. High concentrations are required to significantly damage the skin or respiratory tract. Liquid and vapor exposures to HN are less damaging to the skin of MWDs than are equal concentrations of HD or arsenical blister agents. Exposures of the eye to HN, however, produce more serious lesions than HD exposures. The respiratory, gastrointestinal, and systemic signs and symptoms of HN are similar to those effects caused by HD. Decontamination and treatment for HN are similar to those for HD.

Arsenical Vesicant Agents

Arsenical vesicant agents such as lewisite (L) are more damaging as liquids than as vapors. Exposure to L is immediately painful, and the exposed MWD becomes very restless. Lesions produced by L are more severe and develop faster than those produced by mustard. L on the skin and inhaled L vapors are readily absorbed systemically, producing signs of arsenic poisoning manifested by restlessness, vomiting, bloody diarrhea, shock, weakness, anemia, and pulmonary edema.

British antilewisite (BAL), or dimercaprol, ointment penetrates and neutralizes arsenical blister agents; however, there is no initial MCDM BAL issue for MWDs. The treatment protocol below is based on the availability of BAL ointment and BAL injectable.

- **Local**. The treatment of lesions induced by L is similar to that for other blister agents. To treat localized skin exposures, BAL ointment can be rubbed into the contaminated areas, allowed to remain 5 minutes, and then washed off. Any other protective ointment on the skin must be removed before application of BAL ointment.

- **Systemic**. Systemic treatment for arsenical blister agents is indicated when there is extensive skin exposure that has not been decontaminated within 15 minutes, when a very rapid onset of effects follows exposure, or when systemic signs of arsenic poisoning appear. Systemic therapy consists of the administration of BAL injectable at 2.5 to 5.0 mg per kg by intramuscular (IM) injection. The dosage can be repeated every 4 hours for 2 days, and then two times per day for the next 10 days or until recovery is apparent. Supportive therapy should also be administered, as indicated.

Incapacitating (BZ-Type) Agents

- Clinical signs: increased heart rate, dilated pupils, impaired vision, dry mouth, decreased physical endurance while working, incoordination, behavioral changes, confusion, a lack of normal responses to commands, spontaneous aggressive behavior.
- Decontamination of MWDs: large amounts of soap and water.
- Immediate management: physostigmine salicylate. Provide supportive care; monitor vital signs.

Absorption

Significant absorption of BZ, an incapacitating agent, is most likely to occur through the animal's respiratory tract, but percutaneous and gastrointestinal absorption can also occur.

Signs and Symptoms

BZ-type agents are anticholinergic agents with pharmacological effects similar to those of atropine, although they have a greater effect on the CNS than atropine. The onset of signs following a moderate respiratory exposure can be expected to occur within 10 to 20 minutes. In general, the greater the absorbed dose of BZ-type agents, the shorter the time before onset of signs.

In the MWD, early effects of moderate exposures to BZ include increased heart rate, dilated pupils, impaired vision (shown by bumping into objects), dry mouth, and a decrease in physical

endurance while working. Marked increases in body temperature do not usually occur. The agents' predominant effects are on the CNS, resulting in incoordination, behavioral changes, confusion, and a lack of normal responses to commands. Exposures may incapacitate animals and make them unfit for service.

There is a large margin of safety between incapacitating and lethal exposures to BZ-type agents. Overwhelming exposures, however, can result in prostration and convulsions, with death occurring rapidly. Moderate exposures may cause altered mental status, failure of the MWD to follow commands, and spontaneous aggressive behavior.

Decontamination

For MWDs, use large amounts of water warm and soap. For MWD equipment, use an M295 IEDK or 5% hypochlorite (bleach).

Treatment

There is no initial MCDM issue of physostigmine salicylate for MWDs. **NOTE:** Do not use anesthetics, tranquilizers, and sedatives because they tend to potentiate the effects of incapacitating agents.

After a moderate exposure to BZ, effects on the MWD may persist 24 hours or more. Although the MWD's life is not immediately threatened, therapy can be administered to hasten recovery and return the animal to duty as quickly as possible. However, the MWD should be examined and its work performance evaluated before it is returned to duty.

General therapy for BZ exposure should include restricting activity and providing clean drinking water. Physostigmine salicylate (0.02–0.025 mg/kg, for a total of 1–1.5 mg) can be given by slow intravenous (IV) or IM injections.

Repeated doses of physostigmine salicylate at reduced dosage levels can be given at intervals of 1 to 2 hours until effective; if signs of BZ exposure recur, maintenance doses can be given every 2 to 4 hours. The dosage levels are reduced in continuous therapy to avoid an overdose of physostigmine. The signs of physostigmine overdose include pinpoint pupils, muscle weakness, twitching, vomiting, diarrhea, respiratory

distress, slowed heart rate, and convulsions. If toxicity is noted, administration of physostigmine should be discontinued, and one atropine injector, IM, should be given to control severe effects of overdose.

Cyanide Compounds (Blood Agents)

- Clinical signs (with high concentrations): difficulty breathing, coughing, death.
- Decontamination: usually unnecessary because the agents evaporate quickly.
- Immediate management: the antidote is sodium nitrite and sodium thiosulfate, IV; supportive management consists of oxygen.

Cyanide compounds affect bodily functions by inactivating the cytochrome oxidase system; this poisoning prevents cellular respiration and the normal transfer of oxygen from the blood to body tissues. Hydrogen cyanide (AC) and cyanogen chloride (CK) are the important agents in this group. Cyanogen agents are highly volatile and nonpersistent even at very low temperatures. Exposure at high concentrations causes effects within seconds and death within minutes in unprotected personnel and MWDs. The chlorine in CK also produces central and peripheral pulmonary compartment effects.

Absorption

With agent dispersed from munitions or aircraft, inhalation is the usual route of entry.

Clinical Signs

AC causes asphyxiation of the tissues, especially the respiratory center of the CNS, resulting in difficulty breathing, coughing, and death. In addition to cyanide effects, CK causes marked local irritant effects on the respiratory system, leading to pulmonary edema.

Decontamination

MWD decontamination for cyanide compounds is usually not necessary because the agents evaporate quickly. If the MWD's hair is wet, use large amounts of soap and water.

Initial Treatment

Treatment is difficult under field conditions. It should consist of oxygen therapy under positive pressure ventilation and antidote injections, when available (there is no initial MDCM issue of sodium nitrite and sodium thiosulfate, the antidote, for MWDs).

For MWDs under 85 pounds, inject one sodium nitrite 10-mL (3%) ampule containing 300 mg of sodium nitrite, followed by one 50-mL (25%) ampule containing 12.5 g of sodium thiosulfate, IV. For MWDs over 85 pounds, inject two sodium nitrite 10-mL (3%) ampules containing 300 mg each (total 600 mg) of sodium nitrite, followed by two 50-mL (25%) ampules containing 12.5 g (total 25 g) of sodium thiosulfate, IV. The IVs must be administered slowly, over 3 to 5 minutes.

If the dog's exact weight can be obtained, the initial dosage of sodium nitrite should be approximately 1.8 to 3.2 mg/kg (4–7 mg per pound) IV, followed immediately by sodium thiosulfate at approximately 68 to 136 mg/kg (150–300 mg per pound).

Follow-Up Treatment

If signs of intoxication continue, additional medication may be needed. To determine the dosage, visually examine a small amount of venous blood. If the blood is chocolate brown, indicating the presence of methemoglobin, give an additional injection of sodium thiosulfate at one-half the initial dose because there should be sufficient methemoglobin present from the original dose of sodium nitrite. If the venous blood is red, give additional injections of both sodium nitrite and sodium thiosulfate at one-half the initial dose.

Lung-Damaging (Choking) Agents

- Agents include ammonia, chlorine, HC smoke, oxides of nitrogen (NOx), and phosgene (CG).
- The effects of lung-damaging agents in MWDs are similar to their effects in humans: delayed signs of breathing difficulty, coughing, wheezing, sneezing, and collapse. One difference is that cyanosis (prominent in human casualties of phosgene) is masked in MWDs.
- Decontamination for MWDs: large amounts of warm water.

Treatment

For MWDs exposed to lung-damaging agents, rest should be strictly enforced, especially when pulmonary edema develops, and the dog should be observed closely for 24 to 36 hours. An MWD in shock should be kept comfortably warm and given oxygen, if available. If pneumonia develops, treatment with antibiotics is indicated.

Riot-Control (Irritant) Agents

Under field conditions, the irritant agents bromobenzyl cyanide (CA), chloroacetophenone (CN), and *o*-chlorobenzylidene malononitrile (CS) have little effect on MWDs. CS may cause increased respiration and hyperactivity.

Decontamination

For skin decontamination, a 0.25% solution of sodium sulfite is more effective than saline or water for dissolving and neutralizing the irritant agent and should be used if available.

Treatment

Liquid or solid agents in direct contact with the eyes will cause severe irritation; the eyes should be flushed with saline or water.

Smoke and Incendiary Agents

Burning particles of white phosphorus (WP), the main agent of concern, cause deep burns on contact with the skin. The smoke is generally not toxic. NOTE: Because WP burns spontaneously when exposed to air, oxygen must be excluded to stop the burning. This may be done by submerging the burn or wound in water or by covering it with a water-soaked dressing.

At the earliest opportunity, all WP should be removed from the skin as follows:

1. Bathe the affected part in a bicarbonate solution to neutralize phosphoric acid, which then allows removal of visible WP. Remaining fragments will be observed in dark surroundings as luminescent spots.
2. If the MWD's condition permits, debride the burn promptly to remove bits of phosphorus that might be absorbed later and possibly produce systemic poisoning.
3. After it is certain that all phosphorus has been removed, apply petroleum-based ointment.

Further treatment should be carried out as for thermal burns. Treatment with ultraviolet light is both palliative and therapeutic.

If the eyes are affected, initial treatment consists of irrigation using water or saline. The lids must be separated and a local anesthetic instilled to aid in the removal of all embedded particles. If the eyes are severely ulcerated, atropine ophthalmic ointment should be instilled once all particles have been removed.

Other agents of concern include sulfur trioxide-chlorosulfonic acid solution (FS), titanium tetrachloride (FM), and a chemical mixture (HC). Field concentrations of these agents usually are not harmful to MWDs, but the liquid may cause burns on the skin and in the eyes. After the eyes are irrigated, treat them the same way as for thermal burns.

Toxic Industrial Chemicals and Materials

MWDs are likely to come into contact with toxic industrial chemicals (TICs) and toxic industrial materials (TIMs) during an incident as well as during their daily duties. MWDs are at greater

risk than humans of being exposed to TICs and TIMs because they breathe the air closer to the contaminated ground, walk across contaminated areas, and lick or groom their paws or fur.

Common Types of Toxic Industrial Chemicals and Materials

Hydrocarbons include gasoline, diesel fuel, motor oil, transmission fluid, general cleaners and degreasers, and lubricants. Exposure can occur via oral, ocular, inhalation (vapors, aerosols, particles, or dust), or dermal routes. Clinical signs can be gastrointestinal (vomiting, diarrhea, abdominal pain), ocular (conjunctivitis, corneal irritation or necrosis), respiratory (nasal discharge, nasal bleeding, respiratory distress), dermal (burns, skin eruptions, dermatitis), or associated with the CNS (ataxia, seizures, coma). Hydrocarbon exposure may lead to liver and kidney damage.

Polychlorinated biphenyls (PCBs) have been banned in the United States since 1979. However, older buildings and equipment may still contain PCBs, which could be released during a disaster or fire. PCBs can be aerosols, vapors, oily liquids, or solids. Exposure can occur via oral, inhalation, or dermal routes, and can lead to liver and kidney damage. Additional effects including gastric injury, thyroid suppression, anemia, skin lesions, and reproductive effects; neurobehavioral abnormalities are also possible.

Hazardous metals are of concern when buildings or equipment are damaged or destroyed. Explosions and fires may increase the risk for release of particles or fumes such as lead fumes from lead piping or arsenic from pressure-treated lumber. Some of the more likely hazardous metals MWDs may encounter are arsenic, lead, zinc, cadmium, chromium, thallium, mercury, nickel, cobalt, and beryllium. Exposure is mainly via inhalation but can also be oral. Clinical signs include nonspecific respiratory problems (coughing, respiratory distress, pneumonitis) and gastrointestinal abnormalities (vomiting, diarrhea, abdominal pain).

Asbestos is still used in insulation and concrete and is only a concern when buildings are damaged from explosions or compressive forces. Exposure is mainly due to inhalation, with initial clinical signs of coughing and bronchitis.

Soaps and detergents are only mildly irritating to gastrointestinal and mucous membranes. More alkaline detergents cause ocular, dermal, and gastrointestinal irritation, and potentially corrosive burns and ulcerations to these systems as well. Decontamination for soaps and detergents is large amounts of water.

Acids and alkalis are common in cleaning products. Exposure can occur via oral, ocular, inhalation (acid aerosols, mists, or vapors), and dermal routes. Clinical signs include mild to moderately severe burns for oral, ocular, and dermal exposure and dyspnea and pulmonary edema for inhalation exposure. Decontamination is large amounts of water.

Ethylene glycol and propylene glycol are found in various household and industrial compounds. Exposure is mainly oral with CNS clinical signs of ataxia, weakness, and depression that can progress to renal failure, seizures, and liver damage. Within 1 to 2 hours of ethylene glycol ingestion, induce vomiting or gastric lavage (or both), followed by administration of activated charcoal and sodium sulfate. After 1 to 2 hours, administer 4-methylpyrazole (5% solution [50 mg/mL]) at 20 mg/kg IV initially, followed by 15 mg/kg IV at 12 and 24 hours after ingestion, and 5 mg/kg IV at 36 hours after ingestion. Supportive treatment consists of correcting fluid, electrolyte, and acid-base disorders. Propylene glycol treatment is supportive.

Phenols may be present in large quantities in industrial settings. At low concentrations (< 4.5%), phenols are irritants; at concentrations over 5%, phenols are caustic. Exposure can occur via oral and dermal routes. Clinical signs include oral and esophageal burns, panting, profuse vomiting and diarrhea, salivation, muscle tremors, convulsions, coma, and death. Exposure can also lead to liver and kidney damage. Initial decontamination for phenols consists of large amounts of water under pressure until the phenol odor is gone. Rapid skin decontamination is critical. Flush eyes with copious amounts of water or saline. After the smell of phenol is gone, decontaminate with large amounts of water and soap. In cases of ingestion, do not induce emesis. Administer activated charcoal.

Alcohols, unless ingested in large quantities, do not generally cause severe problems. Exposure occurs via oral, inhalation, and dermal routes. Clinical signs include ataxia, CNS depression, dyspnea, and gastritis.

Common harmful gases are bromine, chlorine, fluorine, hydrogen sulfide, and carbon monoxide. Bromine gas, used in agriculture, sanitation, and petrochemical industries, causes coughing, nosebleeds, and pulmonary edema. Chlorine gas is used in many industries and for sewage treatment. Chlorine causes ocular and respiratory irritation and may cause pulmonary edema. Fluorine gas is used in aluminum and petrochemical industries as well as in dyes, agricultural chemicals, and ceramics. It causes severe ocular and respiratory irritation.

Hydrogen sulfide is produced by various industries such as paper mills, food processing plants, and petroleum refineries. Because hydrogen sulfide is heavier than air, it accumulates in low-lying areas, and it smells like rotten eggs. Clinical signs of hydrogen sulfide exposure are conjunctivitis and pulmonary edema, but large exposures can rapidly induce unconsciousness, seizures, and death. Carbon monoxide is slightly lighter than air and usually poses a risk only when entering poorly ventilated, confined spaces containing motor vehicle smoke or exhaust. Mild clinical signs of carbon monoxide exposure are vomiting and lethargy; moderate clinical signs are dyspnea, weakness, ataxia, tachypnea, and tachycardia; and severe clinical signs are disorientation, severe lethargy, hypotension, syncope, seizures, pulmonary edema, and coma.

Decontamination and Treatment

MWD decontamination for most TICs and TIMs is large amounts of soap and water. Eyes should be irrigated with copious amounts of water, saline, or ophthalmic solution until all contaminants have been removed. Prior to decontamination, check to ensure that the agent involved will not react with water, thus causing further injury. Treatment for TICs and TIMs not listed above is supportive.

Biological Warfare Agents

The initial MCDM issue of doxycycline for MWDs is two bottles of doxycycline, 100-mg tablets (30 tablets per bottle). An alternative is one bottle (30 tablets) of ciprofloxacin, 500-mg tablets. Additional medication may be needed to complete

this treatment. **WARNING:** Do not give doxycycline (or other tetracycline antibiotics) or ciprofloxacin (or other quinolone antibiotics) to an MWD with a known allergy. Contact veterinary personnel for a substitute. Also, doxycycline and ciprofloxacin increase sensitivity to sunlight. Keep the MWD in the shade when possible. Notify veterinary personnel if the MWD develops a rash, hives, vomiting, or diarrhea, or has difficulty breathing.

Diseases produced by offensive use of biological agents could infect animals within the contaminated area; however, most of the diseases likely to be used in biowarfare are unlikely to cause illness in MWDs. This is primarily due to varied species susceptibility between dogs and humans for most biowarfare agents. For definitive information on biowarfare agents, see *Treatment of Biological Warfare Agent Casualties* (Washington, DC: US Army, Marine Corps, Navy, Air Force; 17 July 2000; ATP 4-02.84 (FM 8-284)/MCRP 4-11.1C/NTRP 4-02.23 [NAVMED P-5042]/AFMAN 44-156_IP (AFMAN [I] 44-156).

The response to the threat or use of biowarfare agents may vary depending on whether veterinary medical measures are employed before exposure, or after exposure in the presence of clinical signs. Prior antibiotic prophylaxis may prevent illness in exposed MWDs. Active immunization may be effective against biowarfare in humans, but there are no approved canine immunizations for these agents. The best protective modality for MWDs against a wide variety of biological threats is the use of prophylactic antibiotics and decontamination procedures. Among likely biowarfare agents, MWDs may be susceptible to plague (*Yersinia pestis*), tularemia, brucellosis, Q-fever, and anthrax. Dogs are believed to be less susceptible than humans to all of these diseases. The Department of Defense MWD Veterinary Service currently recommends that all MWDs deployed to areas with high risk of natural tick-borne rickettsial disease be placed on prophylactic doxycycline (6 mg/kg/day). Doxycycline is generally considered efficacious against all biowarfare agents of concern, and the prophylactic dose may provide additional protection for MWDs. Ciprofloxacin may also be used.

Decontamination should be performed with soap and water. MWD equipment should be decontaminated with 5% hypochlorite solution, according to *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Decontamination*.

Nuclear and Radiological Weapons

MWDs exposed to nuclear weapons or radioactive material will present with the same types of medical problems as human patients, including blast, thermal, and radiation injuries and radiation sickness, depending on the amount of radiation received. Veterinary care will be based on the dog's clinical condition and its prognosis for recovery. MWD equipment should be decontaminated according to *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Decontamination*.

For radioactive iodine exposure, potassium iodide (KI) should be administered within 4 hours before or after exposure. The initial MCDM issue of KI for MWDs is one package containing fourteen 130-mg tablets. Administer half a tablet (65 mg) once a day by mouth until instructed by a veterinarian to stop. **WARNING:** Do not start administration of KI if more than 12 hours has passed since exposure.

Notify veterinary personnel if the MWD develops wheezing, difficulty breathing, or swelling of the mouth or throat. In cases of MWDs exposed to other radioactive isotopes, consult the Department of Defense MWD Dog Veterinary Service (210-671-3991/3992, DSN: 312-473-3991/3992) prior to administering any radiotherapy.

Decontamination

Decontamination should occur as quickly as possible after exposure to prevent or reduce any further absorption of the agent and to prevent contamination of other personnel, equipment, and the surrounding area. **NOTE:** All personnel who handle CBRN-contaminated animals must be in MOPP 4 or proper civilian personal protective equipment as determined by the incident commander.

Soap (Castile liquid soap [NSN 8520015190776] or any nonmedicated veterinary shampoo) and warm water are safe for the majority of CBRN agents an MWD could encounter. Using warm water will help prevent hypothermia and assist with removal of contaminants during decontamination.

The initial MCDM issue of RSDL for MWDs is one pouch (contains 3 packets). The MWD handler should carry an extra M295 IEDK for decontamination of MWD equipment.

Eyes. Any amount of agent getting into the eyes of an animal requires prompt action to prevent conjunctival absorption, which can occur very rapidly. The eyes should be decontaminated by irrigation with copious amounts of water, saline, or ophthalmic solution until all contaminants have been removed. After decontamination is complete, the eyes should be thoroughly evaluated and treated with appropriate ointments. **CAUTION:** Do not use RSDL in or around eyes. RSDL and soap can cause further injury and both must be kept out of an MWD's eyes. Likewise, eye ointments can absorb and concentrate agents, causing additional damage and toxicity, so they must not be used until the eyes have been thoroughly decontaminated and examined.

Hair and skin. Because the dog's coat delays penetration of agents to the skin and cutaneous absorption requires several minutes, effective decontamination of the hair and skin may be carried out before any significant absorption has occurred. However, decontamination is not a substitute for treatment. When the animal shows signs of exposure to a CBRN agent, specific therapy should be initiated.

Immediate Decontamination

The MWD's entire body should be wiped down using the RSDL, except for eyes and the periocular area, as soon after nerve agent or HD exposure as possible. For other contaminants, soap and warm water can be used for MWD decontamination. The eyes should be flushed with large amounts of water, ophthalmic solution, or saline. If soap is not available, rinsing with large amounts of water is the next best method of decontamination. Allow the MWD to shake off excess water and dry it with a clean towel or other absorbent cloth.

Thorough Decontamination

The preferred method of decontaminating the MWD is by first using RSDL (for nerve agents and HD), then thoroughly washing and rinsing the MWD to ensure all contaminants are removed. Thorough MWD decontamination should be completed by

washing the hair down to the skin with soap and warm water. It is important that all body surface areas are saturated with soap and water and gently scrubbed. After the washing is completed, the hair and skin should be rinsed until the soap residue is completely removed. If soap is not available, rinsing with large amounts of water is the next best method of decontamination. Step-by-step decontamination instructions are as follows:

1. Rinse the MWD thoroughly with plain water beginning at the head, then moving along the back to the tail. Then rinse down the MWD's sides, chest, stomach, legs, and paws.
2. Work the soap into the hair starting the head, then moving along the back and to the tip of the tail, then work down the MWD's sides, chest, abdomen, legs, and paws. Make sure the soap reaches the MWD's skin. If the MWD has erect ears, flush the ears with otic solution or water.
   NOTE: Special attention should be paid to the MWD's stomach, face, ears, eyes, under tail, paws, and between the legs to ensure all contamination is removed.
3. Flush the eyes with copious amounts of water, ophthalmic solution, or saline.
4. Rinse the dog with plain water using the same pattern as the initial rinse (head to back to tail, then down sides, chest, stomach, legs, and paws).
5. Allow the MWD to shake off excess water. A tarp or other impervious material may be placed around the dog while it shakes off excess water to prevent contamination of other people, MWDs, or equipment.
   NOTE: Steps 1 through 5 may need to be repeated until all contaminants are removed.
6. Dry the MWD with clean towels or other absorbent cloth.

MWD Equipment

The leash, collar, and muzzle should be removed from the MWD and decontaminated as soon as possible. These items may be decontaminated using an M295 IEDK, soap and water, 5% hypochlorite (bleach) solution. Additional guidance for decontamination of equipment is contained in *Multiservice Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Decontamination*.

Appendix A

EQUIPMENT LIST

MCU-2A/P Protective Mask

Size	*National Stock Number (NSN)*
S	4240-01-327-4148
M	4240-01-327-4149
L	4240-01-327-4150

M40A1 Chemical Biological Field Protective Mask

Size	*NSN*
S	4240-01-258-0061
M	4240-01-258-0062
L	4240-01-258-0063

M42A2 Chemical Biological Combat Vehicle Protective Mask

Size	*NSN*
S	4240-01-413-4100
M	4240-01-413-4101
L	4240-01-413-4102

M45 Air Crew/Land Warrior Chem-Bio Mask System

Size	*NSN*
XS	4240-01-414-4034
S	4240-01-414-4035
M	4240-01-414-4051
L	4240-01-414-4052

M50 Field Protective Joint Service General Purpose Mask

Size	*NSN*
S	4240-01-512-4431
M	4240-01-512-4434
L	4240-01-512-4437

M51 Combat Vehicle Joint Service General Purpose Mask

Size	*NSN*
S	4240-01-512-4431
M	4240-01-512-4434
L	4240-01-512-4437

Universal Camouflage Joint Service Lightweight Integrated Suit Technology (JSLIST) Coat, Type II

Size	*NSN*
3XLL	8415-01-553-0073
2XLL	8415-01-553-0072
XLL	8415-01-553-0071
XLR	8415-01-553-0070
LL	8415-01-553-0069
LR	8415-01-553-0037
ML	8415-01-553-0035
MR	8415-01-553-0034
MS	8415-01-553-0033
SS	8415-01-552-9992

Universal Camouflage JSLIST Trousers, Type II

Size	*NSN*
3XLL	8415-01-552-9983
2XLL	8415-01-552-9981
XLL	8415-01-552-9977
XLR	8415-01-552-9976
LL	8415-01-552-9974
LR	8415-01-552-9975
ML	8415-01-552-9971
MR	8415-01-552-9970
MS	8415-01-552-9968
SS	8415-01-552-9966

Desert JSLIST Coat

Size	*NSN*
XLL	8415-01-505-1616
XLR	8415-01-509-8314
2XLL	8415-01-505-1622
3XLL	8415-01-506-7710
LL	8415-01-444-6131
LR	8415-01-444-6138
ML	8415-01-444-6131
MR	8415-01-444-5926
MS	8415-01-444-5913
SS	8415-01-444-5905
SXS	8415-01-444-5902

Desert JSLIST Trousers

Size	*NSN*
XLL	8415-01-505-1567
XLR	8415-01-509-8269
2XLL	8415-01-505-1591
3XLL	8415-01-506-7713
LL	8415-01-444-5900
LR	8415-01-444-5898
ML	8415-01-444-5892
MR	8415-01-444-5893
MS	8415-01-444-5506
SS	8415-01-444-5504
SXS	8415-01-444-5417

Woodland JSLIST Coat

Size	*NSN*
XLL	8415-01-444-1241
XLR	8415-01-509-8296
2XLL	8415-01-505-1591
3XLL	8415-01-506-7546
LL	8415-01-444-1270
LR	8415-01-444-1265
ML	8415-01-444-1249
MR	8415-01-444-1238
MS	8415-01-444-1200
SS	8415-01-444-1169
SXS	8415-01-444-1163

Woodland JSLIST Trousers

Size	*NSN*
XLL	8415-01-505-1274
XLR	8415-01-509-8265
2XLL	8415-01-505-1591
3XLL	8415-01-506-7698
LL	8415-01-444-2338
LR	8415-01-444-2325
ML	8415-01-444-2308
MR	8415-01-444-2310
MS	8415-01-444-1613
SS	8415-01-444-1439
SXS	8415-01-444-1435

JSLIST Block 2 Glove Upgrade, Non-Flame Resistant

Size	*NSN*
Small	8415-21-921-2165
Med/Narrow	8415-21-921-2166
Medium	8415-21-921-2167
Lg/Narrow	8415-21-921-2169
Large	8415-21-921-2170
XL/Narrow	8415-21-921-2171

Chemical/Biological/Radiological/Nuclear Lightweight Overboots Alternative Footwear Solution

Size	*NSN*
X-Sm	8430-01-553-6290
Small	8430-01-536-5413
Medium	8430-01-536-5415
Large	8430-01-536-5416
X-Large	8430-01-536-5419
XX-Large	8430-01-553-6283

Appendix B

PREPARATION OF PATIENT DECONTAMINATION SOLUTIONS

The two types of patient decontamination solutions, 0.5% and 5% hypochlorite, must be mixed in containers that can be closed after completion. The solutions will remain at the required strength far longer in closed than in open containers. The recommended mixing container is a 5-gallon water can. The most effective method for mixing is to agitate hypochlorite granules as they are poured into the water, and then to allow the solution to sit for 20 minutes to ensure the granules dissolve. The granules must be completely dissolved in the water. Follow the specific steps for each solution below.

0.5% Hypochlorite Solution

Using 6-oz bottles of calcium hypochlorite granules contained in the Chemical Agent Patient Decontamination medical equipment set (MES), mix one bottle into 5 gallons of water. If a bulk package of calcium hypochlorite is used as an additional supply, retain one empty 6-oz bottle from the MES to measure the correct amount of dry granules and mix as described.

If neither source of calcium hypochlorite granules is available, household bleach is an alternative, usually packaged in 1-quart or 1-gallon bottles. Mix 2 quarts of bleach into 4.5 gallons of water, and store the solution in a closed container until ready to use.

5.0% Hypochlorite Solution

Using 6-oz bottles of calcium hypochlorite granules found in the Chemical Agent Patient Decontamination MES, mix eight bottles into 5 gallons of water. If a bulk package of calcium hypochlorite is used as an additional supply, retain one empty 6-oz bottle from the MES to measure the correct amount of dry granules and mix as described. If neither is available, use household bleach straight from the bottle; do not mix in water.

Appendix C

MEDICAL EQUIPMENT SETS

Chemical Agent Patient Treatment Set (30 Patients)

6545-01-5375022, MES CHEM AG TRMT-2006

6140015009672	Rechargeable battery	Ea	24
6505009269083	Atropine injection, 0.7 mL	Ea	150
6505011253248	Pralidoxime Chl injection, 2 mL	Ea	60
6505012740951	Diazepam injection, 2 mL, 10 mg (5 mL/mg)	Ea	100
6505014542525	Atropine sulfate opht	Tu	12
6505015053476	Diazepam inj, 2 mL, 10S, 10 mg (5 mL/mg)	Pg	10
6505015382871	Albuterol sulfate inh	Ea	5
6505015984306	Antidote treatment	Ea	30
6505016129939	Amyl nitrite inhala	Pg	1
6515007540412	Hypodermic syringe 100S	Pg	1
6515007542834	Hypodermic needle, 18-gauge 100S	Pg	2
6515011643038	Hypodermic syringe, 60 mL 100	Pg	1
6515011688108	Hypodermic syringe, 10 mL 100S	Pg	1
6515013386602	Hand-operated resuscitator	Ea	4
6515014350050	Suction App Surg Prog	Ea	2
6515014676692	Airway Nasophary Sz 28	Pg	6
6515014929182	Infusion set 200S	Pg	1
6515015213082	Pharyngeal airway, 2S	Pg	6
6515015213095	Pharyngeal airway	Ea	12
6515015328056	Hypothermia Managem	Ea	30
6515015382141	Chamber Medication	Ea	5
6515015456329	Leg case table kit	Ea	1
6515015590741	Holder Injector Syr	Ea	4
6530015196886	Bag Sterilization 10s	Pg	1
6545015338202	Medical instrument case	Ea	3
6545015771047	Chemical patient wrap kit	Ea	1
6630013780273	Blood collecting unit 200	Pg	1
6640015007721	Airflow indicator	Ea	1
7520003126124	Tube-type marker	Dz	1
8415011382496	Chemical glove inserts	Pr	25
8415011382503	Chemical protective gloves, large	Pr	7

Dz: dozen; Ea: each; Pg: package; Pr: pair; Tu: tube

Chemical Agent Decontamination Set (60 Patients)

6564-01-5375019, CHEM AGT PA-2006

6505015075074	Reactive Skin Decontamination Lotion	Pg	2
6515011643038	Hypodermic syringe, 60 mL, 100	Pg	1
6515011688108	Hypodermic syringe, 10 mL, 100S	Pg	1
6515015456329	Leg case table kit	Ea	1
6515015989737	Scissors Bandage	Ea	25
6530013807309	Folding litter, 91.60"	Ea	4
6530015233314	Litter support	Pr	10
6545015338202	Medical instrument case	Ea	3
6545015456291	Medical instrument case	Ea	1
6665000508529	Chemical agent paper (M8), 25S	Bk	6
6665012265589	Chemical agent paper (M9)	Ro	1
6840013584336	Disinfectant Calcium Hypochlorite	Bg	25
7240002461097	Plastic utility pail, 3 gallon	Ea	10
7520003126124	Tube-type marker	Dz	1
7540014608995	Printed form	Bk	10
7920008841115	Cellulose sponge Rect	Ea	60
8105001913902	Plastic bag	Ro	2
8135006181783	Polyester plastic sheet	Ro	1
8415002817813	TAP apron, small	Ea	4
8415002817814	TAP apron, medium	Ea	8
8415002817815	TAP apron, large	Ea	4
8415010333517	Chemical protective glove set	Se	6
8415010333518	Chemical protective glove set	Se	10
8415010333519	Chemical protective glove set	Se	1
8415011382494	Chemical glove inserts, small	Pr	2
8415011382495	Glove inserts, medium	Pr	2
8415011382496	Chemical glove inserts	Pr	2

Bg: bag; Bk: book; Dz: dozen; Ea: each; Pg: package; Pr: pair; Ro: roll; Se: set; TAP: toxicological agent protective

Appendix D

PATIENT DECONTAMINATION STATION DIAGRAMS

The following diagrams display two distinct patient decontamination layouts (see Chapter 10). Diagram 1 shows a detailed patient decontamination site layout, and diagram 2 shows the flow of casualty decontamination from the arrival point to the clean disposition area.

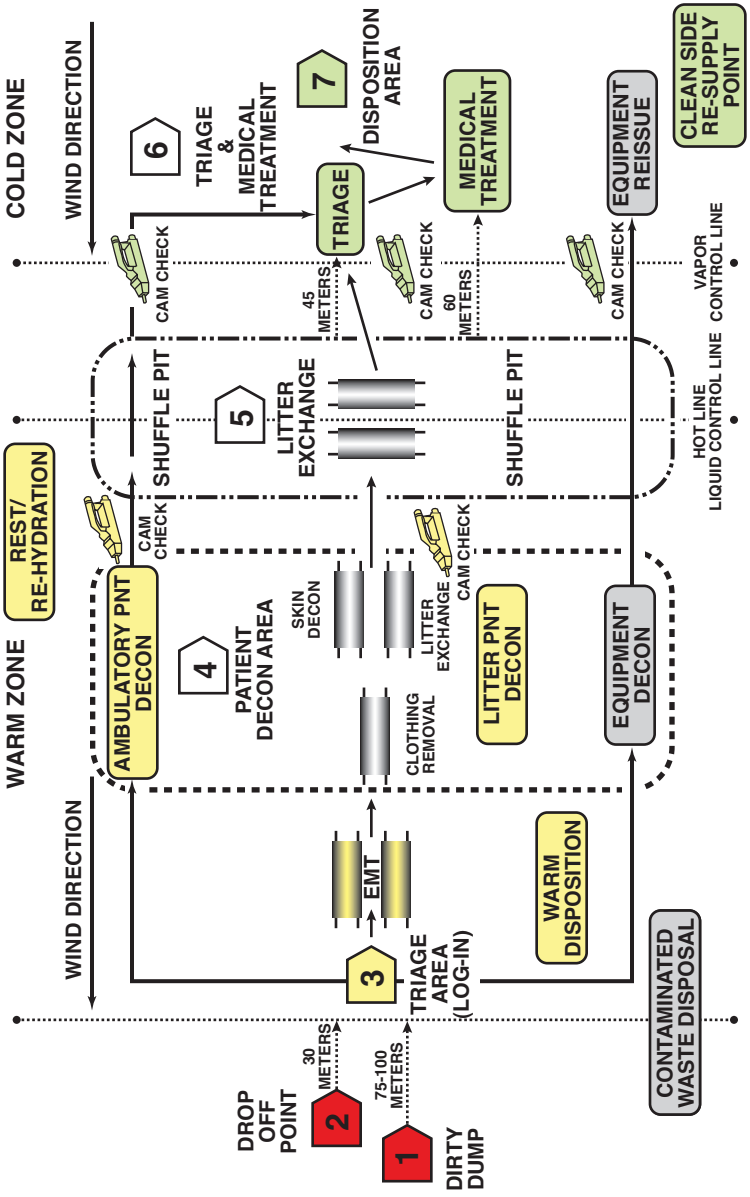

Diagram 1. Patient decontamination site layout. CAM: Chemical Agent Monitor; decon: decontamination; EMT: emergency medical treatment; PNT: patient

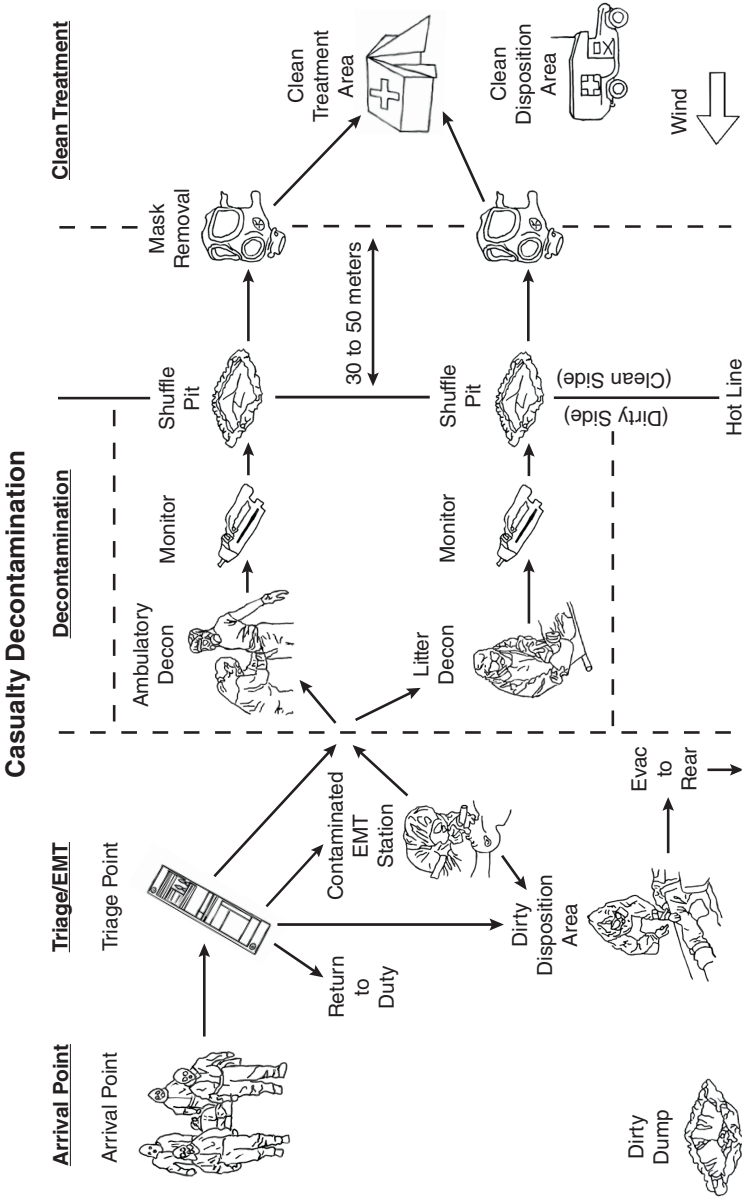

Diagram 2. Casualty decontamination procedure. EMT: emergency medical treatment

Appendix E

GLOSSARY OF TERMS AND ACRONYMS

ABCs. airway, breathing, circulation

AC. hydrogen cyanide

ACADA. Automatic Chemical Agent Detector Alarm; this area monitoring detector sounds a warning when it senses the vapors of blister and nerve agents

Acetylcholine. a chemical released by certain nerves that stimulates a muscle, gland, or another nerve; one of a number of neurotransmitters in the body that carry "messages" from nerves to other organs.

Acetylcholinesterase. an enzyme (a protein produced in the cells) that stops the action of acetylcholine by destroying it. This action occurs as soon as acetylcholine has produced a muscle contraction or stimulated a gland or nerve. Nerve agents combine with acetylcholinesterase to prevent it from destroying acetylcholine; acetylcholine accumulates in excess and continues to stimulate the muscle, gland, or nerve.

ACh. acetylcholine

AChE. acetylcholinesterase

Acid. a substance with a pH less than 7

Aerosol. a gaseous suspension of fine solid or liquid particles

AFS. Alternative Footwear Solution

Alkali. a substance with a pH greater than 7

Alveoli. microscopic air sacs in the lungs where oxygen and carbon dioxide diffusion (movement) takes place through alveolar walls

Anesthetic. any agent that causes unconsciousness or insensitivity to pain

Antibiotic. a natural or synthetic substance that inhibits the growth of or destroys microorganisms; used extensively in the treatment of infectious diseases

Anticholinergic. an agent or chemical that blocks or impedes the action of acetylcholine, such as the antidote atropine

Anticholinesterase. a substance that blocks the action of cholinesterase (acetylcholinesterase), such as a nerve agent

Apnea. absence or cessation of breathing

ARDS. acute respiratory distress syndrome

Asphyxiation. unconsciousness or death caused by lack of oxygen

Atelectasis. collapse of the alveoli of the lungs secondary to mucous plugs, foreign bodies, or secretions, frequently associated with pneumonia; best treated by vigorous coughing and breathing exercises, as well as positive end-expiratory pressure

ATNAA. Antidote Treatment Nerve Agent Autoinjector

BAL. British antilewisite

Blepharospasm. a twitching or spasmodic contraction of muscles around the eye; if severe, can lead to difficulty opening the eyes

Bradycardia. a slow heart rate (< 60 beats per minute)

Bronchi. the finer, smaller divisions of the windpipe as it enters the lungs

Bronchoconstriction or bronchospasm. constriction of the bronchial tubes, making it difficult to move air in and out of the lungs

Bronchopneumonia. inflammation of the terminal bronchioles and alveoli, causing edema and consolidation of alveoli

BZ. an anticholinergic incapacitating agent

C2A1 filter canister. the standard filter used on the military mask; protects against historical chemical warfare agents

CANA. Convulsive Antidote, Nerve Agent

Capillaries. small blood vessels

CARC. chemical agent-resistant coating

CBRN. chemical, biological, radiological, or nuclear

Central airway. the airway segment that transports air from the nose and mouth to the lungs

CFR. case fatality rate

CG. a pulmonary agent

Cilia. hair-like cells in the respiratory and gastrointestinal tract that assist with mucous mobilization

Ciliary. pertaining to certain structures in the eye such as the ciliary muscles

CK. cyanogen chloride

CN. a riot-control agent

CNS. central nervous system

Conjunctiva. the delicate membrane that lines the eyelids and covers the exposed surface of the sclera

Conjunctivitis. inflammation of the conjunctiva

Cornea. the transparent anterior portion of the eye, comprising about one-sixth of its surface, through which light passes to transmit images to the retina; it is continuous at its periphery with the sclera and composed of five layers

CR. riot-control agent

CS. riot-control agent

Ct. concentration-time product

CWC. Chemical Warfare Convention

CX. a vesicating agent

Cyanosis. slightly bluish, grayish, slate-like, or dark purple discoloration of the skin due to oxygen in the blood

Cyclitis. inflammation of the ciliary body of the eye

Dermatitis. an inflammation or infection of the skin

Dermis. the deeper layer of the skin under the epidermis, containing the hair follicles, sweat glands, and sebaceous glands

DHD. downwind hazard distance

DM. a riot-control agent, also known as adamsite

Dyspnea. labored breathing resulting from an increased need for oxygen or inadequate air exchange in the lungs

ECP. entry control point

Edema. swelling of the tissues because of fluid

ELISA. enzyme-linked immunosorbent assay

Emphysema. process of trapping air in the alveoli, associated with loss of elasticity of the lung tissues and resulting in inability to exhale completely

EMT. emergency medical treatment

Epidermis. the outer layer of the skin

Epithelium. the inner layer of tissue in hollow organs

Erythema. red area of skin caused by heat or cold injury, trauma, or inflammation; may be localized or generalized

Fasciculation. localized contraction of muscle fibers, usually visible through the skin

FDA. Food and Drug Administration

Fibrosis. scar tissue; or replacement of normal tissue by fibrous tissue

FiO_2. fracture of expired oxygen

Flaccid paralysis. loss of muscle tone and capability to function; nerve agents cause this condition

FM. titanium tetrachloride

FMC. field medical card

FR. flame-resistant

FS. sulfur trioxide-chlorosulfonic acid solution

GA. tabun

GB. sarin

GD. soman

GF. a nerve agent

GI. gastrointestinal

Granulocytopenia. decrease in white cells of the granulocyte series in the bloodstream

H, HD. mustard

HC smoke. military tactical smoke

Hematopoietic. pertaining to production and development of blood cells

Hemoconcentration. a relative increase in the number of red blood cells, usually resulting from a decrease in the volume of plasma

HL. mixture of mustard and lewisite

HN3. nitrogen mustard

Hyperemia. redness of the skin

Hypertension. high blood pressure

Hypotension. low blood pressure; if blood pressure is too low, shock and death may occur

Hypovolemic shock. insufficient blood volume to maintain adequate tissue oxygenation and aerobic metabolism

Hypoxemia or **hypoxia.** insufficient oxygen in the circulatory system to adequately supply tissue cells; may be caused by lack of oxygen, inadequate hemoglobin to carry oxygen, or interference with transfer of oxygen to the cells

ICAD. Individual Chemical Agent Detector

ICAM. Improved Chemical Agent Monitor

ICt_{50}. median incapacitating dose via vapor

ID_{50}. median incapacitating dose

IEDK. Individual Equipment Decontamination Kit

IM. intramuscular

Intubation. the process of enhancing respiration by providing an artificial airway

IPE. individual protective equipment

IV. intravenous

JB2GU. JSLIST Block 2 Glove Upgrade

JCAD. Joint Chemical Agent Detector

JSGPM. Joint Service General Purpose Mask

JSLIST. Joint Service Lightweight Integrated Suit Technology

KI. potassium iodide

L. lewisite

Laryngospasm. spasmodic closure of the larynx (voicebox at the top of the trachea/windpipe)

Larynx. voicebox and vocal cords

LCt_{50}. median lethal concentration

LD_{50}. median lethal dose

Leukocytosis. above normal increase of white blood cells

Leukopenia. less than normal number of white blood cells

LSD. lysergic acid diethylamide-25

Lymphadenitis. inflammation of lymph nodes, usually caused by a focus of infection distal to the node cells

Malaise. a feeling of illness or depression

MCDM. medical CBRN defense materiel

MCt_{50}. concentration that causes miosis in half the exposed population

MDMA. 3,4-methylenedioxy-methamphetamine, popularly known as ecstasy

MES. medical equipment set

Miosis. small, "pinpoint" pupils

MOPP. mission-oriented protective posture

MRE. meal, ready to eat

MTF. medical treatment facility

MTOE. modified table of organization and equipment

MWD. military working dog

Mydriasis. large or dilated pupils

Naloxone or **naltrexone.** an opioid antagonist that rapidly reverses the effects of opioids

Nasopharynx. the area of the nose and upper airway

NBC. nuclear, biological, chemical

NCO. noncommissioned officer

NCOIC. noncommissioned officer-in-charge

Necrosis. death of tissue

Necrotic. pertaining to necrosis or end result of necrosis; dead

nFR. non–flame-resistant

NOx. oxides of nitrogen; toxic smoke that can cause pulmonary edema. Produced by exploding munitions, and industrial smoke, and in grain silos as a product of grain fermentation

NSN. national stock number

OC. oleoresin capsicum

OIC. officer-in-charge

Oropharynx. the mouth and upper airway

PA. physician assistant

2-PAM Cl. pralidoxime chloride

PCB. polychlorinated biphenyl

PCP. phencyclidine

PDS. patient decontamination station

PFIB. toxic smoke produced by Teflon (DuPont, Wilmington, DE) burning at over 700˚F

Pruritis. itching

Pulmonary edema. fluid in the lungs, associated with an outpouring of fluids from the capillaries into the pulmonary spaces (air sacs or alveoli) producing severe shortness of breath. In later stages, produces expectoration of frothy, pink fluid and blue lips (cyanosis)

RDIC. Resuscitation Device, Individual Chemical

Resin. a semi-solid, sometimes sticky substance produced by plants

Rhinitis. inflammation of nasal mucosa

Rhinorrhea. thin watery discharge from the nose; runny nose

RSCAAL. Remote Sensing Chemical Agent Alarm

RSDL. Reactive Skin Decontamination Lotion

SEB. staphylococcal enterotoxin B

SNAPP. soman nerve agent pyridostigmine pretreatment

STB. super tropical bleach

Tachycardia. a rapid heart rate (> 100 beats per minute)

TAP. toxicological agent protective (eg, TAP apron)

TCN. tetracycline

Thrombocytopenia. an absolute decrease in circulating platelets in the blood

TIC. toxic industrial chemical; a chemical with a toxicity equal to or greater than ammonia that is produced more than 30 times a year by an industrial facility

TIM. toxic industrial material

Trachea. windpipe

Urticant. something that causes itching or stinging and a raised area on the skin (wheal)

USAMRICD. US Army Medical Research Institute of Chemical Defense

Vapor. fumes given off by a liquid

Vascularization. development of new blood vessels in a structure

Vasoconstriction. reduced interior size of a blood vessel with a decrease in blood flow

VCL. vapor control line

VEE. viral equine encephalitis

Vertigo. dizziness

Vesicant. agent that causes a vesicle (blister)

Vesication. blistering

VHF. viral hemorrhagic fever

VX. a nerve agent

WP. white phosphorus

Zoonosis. a disease of animals that may be transmitted to humans under natural conditions

Zoonotic. transmissible from animals to humans under natural conditions

INDEX

A

Abrin, 70
AC. *See* Hydrogen cyanide
ACADA. *See* Automatic Chemical Agent Alarm
ACAM2000 vaccine, 65
Acetylcholinesterase
  nerve agent effect, 3–6, 15–16
AChE. *See* Acetylcholinesterase
Acids
  military working dogs exposure, 169
Action potentials, 3
Aflatoxins, 69
Agent 15. *See* Incapacitating agents
Air sacs
  effect of phosgene, 39
Airway. *See* Respiratory system
Alarms, 144
Alcohols
  military working dogs exposure, 169
Alkalis
  military working dogs exposure, 169
Alternative Footwear Solution, 136
Aluminum powder, 37
Alveolar-capillary membrane, 39
Alveoli
  description of, 34–35
  effect of phosgene, 39
Ambulatory casualty decontamination, 121–129
Ammonia, 35–38
Amphetamines
  as incapacitating agents, 50
Amyl nitrite, 31–32
Anthrax, 60–61
Antibacterial creams, 27
Antibiotic eye ointment, 25
Anticholinergics. *See* Incapacitating agents
Antidote Treatment Nerve Agent Autoinjectors
  nerve agents, 1, 10–14, 105
Antidotes
  cyanide, 29
  incapacitating agents, 49, 51
  nerve agents, 8–15
Antipsychotics
  as incapacitating agents, 50
Apnea
  nerve agent effect, 5
Argentinean hemorrhagic fever, 66
Arsenical vesicant agents, 161
Asbestos
  military working dogs exposure, 168
Assisted ventilation
  nerve agent treatment, 15
ATNAAs. *See* Antidote Treatment Nerve Agent Autoinjectors
Atropine
  nerve agent treatment, 10, 13–15
Automatic Chemical Agent Alarm, 1, 19, 73, 144

B

Bacillus anthracis, 60–61
BAL. *See* British antilewisite
Barbiturates
  as incapacitating agents, 50
Benzodiazapines
  as incapacitating agents, 50
Betadine, 59
Bio Thrax, 61
Biological agents
  appearance of weaponized agents, 55–56
  attacks, 87–89
  categories of, 54
  characteristics of, 53–55
  decontamination, 59–60
  detection of, 56
  downwind hazard distance, 88

epidemiology, 57–58
major threats, 60–66
medical evacuation, 60
military working dogs exposure, 170–171
overview, 53
portals of entry, 54
psychological manifestations, 55
recognition of an attack, 55–58
responding to an attack, 58–59
sample processing, 56–57
triage, 60
Type P attacks, 88
Type Q attacks, 88
Type R attacks, 88
Type S attacks, 88
types of attacks, 88
Biological Integrated Detection System, 56
Blister agent conjunctivitis, 25
Blister agents. *See* Vesicants
Blisters
vesicants injuries, 26–27
Blood agents. *See* Cyanide
Bolivian hemorrhagic fever, 66
Botulinum toxins, 68–69
Brain
nerve agent effect, 7
British antilewisite, 161
Bronchi
description of, 34–35
inflammation of, 39
Bronchioles
effect of phosgene, 39
Bronchorrhea
nerve agent effect, 6
Buboes, 63
Bubonic plague, 62–63
Buddy aid
cyanides, 31
incapacitating agents, 51
nerve agent, 8–14
riot-control agents, 46
vesicants, 23–24
BZ. *See* Incapacitating agents

C

C2A1 filter canisters, 38, 132
Caffeine
as incapacitating agent, 50
CANAs. *See* Convulsive Antidote, Nerve Agent
Capillaries
description of, 34–35
effect of phosgene, 39
Capsaicin, 44, 46
Carbon tetrachloride, 36
CARC. *See* Chemical agent resistant coating
Cardiac muscle
nerve agent effects, 6
Case fatality rate
anthrax, 60
cholera, 61
plague, 62
smallpox, 64
tularemia, 65
viral hemorrhagic fevers, 66
CBRN. *See* Chemical, biological, radiological, or nuclear casualties
Central airway compartment, 34–35, 38
Central nervous system
nerve agent effects, 7
Central nervous system stimulants
as incapacitating agents, 50
CFR. *See* Case fatality rate
CG. *See* Phosgene
Chemical, Biological, Radiological, and Nuclear Warning and Reporting System, 89
Chemical, biological, radiological, or nuclear casualties
military working dogs and, 149–150
triage categories, 78–80
Chemical Agent Alarm, 1, 19, 73, 144
Chemical Agent Detector Kit, 1, 19, 29, 30, 33, 73, 140–141
Chemical agent detector paper, 1, 19, 73, 86–87, 99, 105, 139–140
Chemical agent resistant coating, 97
Chemical agents. *See also* specific chemical agents
attacks, 85–87
decontamination, 84–87
evaluation of casualties, 76–77
Type A attack, 85–86
Type B attack, 86–87, 89
Type C attack, 87

Chemical-biological protective mask, 134
Chemical Warfare Agent Detector, 1
Chemical Water Testing Kit, 19, 29, 144–146
Chlorine, 37
Chloropicrin, 44
Choking agents. *See* Lung-damaging agents
Cholera, 61–62
Cholinergic crisis, 4
Cholinergic neurons, 3
Ciprofloxacin, 61, 65, 170–171
CK. *See* Cyanogen chloride
Cl. *See* Chlorine
Clostridium botulinum, 68–69
Clostridium perfringens, 70
CN. *See* Riot-control agents
Cocaine
  as incapacitating agent, 50
Concentration-time product, 2
Conjunctivitis
  blister agent effects, 25
Contamination Sign Kit, 92
Convulsive Antidote, Nerve Agent, 1, 11–15, 73, 105
Coxiella burnetti, 63–64
CR. *See* Riot-control agents
Crimean-Congo hemorrhagic fever, 66
CS. *See* Riot-control agents
Ct. *See* Concentration-time product
Cyanide
  absorption, 164
  attacks, 86
  buddy aid, 31
  care provider actions, 31–32
  decontamination, 29, 165
  detection of, 30
  effects of, 30–31
  field detection, 29
  medical management, 29
  military working dogs exposure, 164–165
  NATO Codes, 29
  overview, 29–30
  physical characteristics, 30
  self-aid, 31
  signs and symptoms, 29, 164–165
  treatment, 165
Cyanogen chloride
  attacks, 86
  buddy aid, 31
  detection of, 30
  effects of, 30–31
  overview, 29–30
  physical characteristics, 30
  self-aid, 31
  signs and symptoms, 31
  time of onset, 31

D

Decontaminable Litter, 147–148
Decontamination. *See also* Patient decontamination sites
  biological agents, 59–60, 83
  biological contamination, 87–89
  chemical contamination, 84–87
  cyanide, 29, 165
  immediate, 82
  incapacitating agents, 49, 52, 163
  levels of, 82
  litter casualty decontamination, 110–121
  lung-damaging agents, 33
  military working dogs, 172–174
  moving casualties through decontamination site, 80
  nerve agents, 1, 10, 155
  overview, 81–82
  patient operational decontamination, 82
  patient thorough decontamination, 82
  riot-control agents, 43, 47, 166
  tactical planning, 89–90
  toxic industrial chemicals, 33, 170
  toxins, 67, 68
  training, 72–74
  vesicants, 19, 160
Deliriants
  as incapacitating agents, 50
Delusions, 51
Dengue, 66
Detectors, 138–146
Detergents
  military working dogs exposure, 169

Dexamethasone sodium phosphate-neomycin ophthalmic ointment, 25
DHD. *See* Downwind hazard distance
Diazepam
  nerve agent treatment, 11, 13–15
Dimercaprol, 161
Distilled mustard
  military working dogs exposure, 158
DM. *See* Riot-control agents
Dogs. *See* Military working dogs
Domoic acid, 70
Downwind hazard distance, 88
Doxycycline, 61, 62, 63, 64, 170–171
Dry land drowning, 39

E

Ebola virus, 66
ECP. *See* Entry control points
Ecstasy
  as incapacitating agent, 50
Emergency medical treatment
  patient decontamination sites, 100, 104–105
EMT. *See* Emergency medical treatment
Entry control points, 99–100, 102
Epibatidine, 70
Epsilon toxin, 70
Erythema
  vesicants injuries, 25–26
Ethylene glycol
  military working dogs exposure, 169
Evacuation. *See* Medical evacuation
Exposure history, 74–76
Eyes
  nerve agent injuries, 4–5, 153
  vesicants exposure, 25–26, 159

F

Fasciculation
  nerve agent effect, 7
Field detection
  cyanide, 29
  incapacitating agents, 49
  lung-damaging agents, 33
  nerve agents, 1
  toxic industrial chemicals, 33
Field management
  casualty evaluation, 76–80
  chemical casualties, 76–77
  exposure history, 74–76
  moving casualties through decontamination site, 80
  preparedness, 71–72
  training, 72–74
  triage categories, 78–80
Field medical cards, 112
Filter canisters, 38
FMC. *See* Field medical cards
Foam plastics, 36
Food and Drug Administration, 15
Footwear, 136
Fox Reconnaissance System, 1, 19, 33
Francisella tularensis, 65–66

G

G-agents. *See* Nerve agents
GA. *See* Nerve agents
Gases
  military working dogs exposure, 170
Gastrointestinal tract
  nerve agent effects, 6
  vesicants exposure, 159
GB. *See* Nerve agents
GD. *See* Nerve agents
GF. *See* Nerve agents
Grained aluminum, 37
Gunpowder, 36

H

H. *See* Sulfur mustard
Hantavirus, 66
Hazardous metals
  military working dogs exposure, 168
HC smoke, 37
HD. *See* Sulfur mustard
Heart
  nerve agent effects, 6
Hexachloroethane, 37
HL. *See* Sulfur mustard/lewisite mixture
Hydrocarbons
  military working dogs exposure, 168

Hydrochloric acid, 37
Hydrogen cyanide
attacks, 86
buddy aid, 31
detection of, 30
effects of, 30–31
overview, 29–30
physical characteristics, 30
self-aid, 31
signs and symptoms, 31
time of onset, 31
Hydrogen sulfide
military working dogs exposure, 170
Hypochlorate solution, 19
Hypochlorite solution, 1, 59

I

ICAM. *See* Improved Chemical Agent Monitor; Individual Chemical Agent Alarm
Improved Chemical Agent Monitor, 1, 73, 86, 141–142
Incapacitating agents
absorption, 162
buddy aid, 51
care provider actions, 51
decontamination, 49, 52, 163
detection of, 50
effects of, 50–51
field detection, 49
medical management, 49
military working dogs exposure, 162–164
NATO Code, 49
overview, 49–50
physical characteristics, 50
self-aid, 51
signs and symptoms, 49, 162–163
treatment, 163–164
Incapacitating dose
nerve agents, 2
Incendiary agents
military working dogs exposure, 167
Individual Chemical Agent Alarm, 19
Individual Equipment Decontamination Kit, 24, 138
Individual protective equipment
alarms, 144
Alternative Footwear Solution, 136
decontamination of, 82
detection, 138–146
individual decontamination, 137–138
individual decontamination kit, 24, 138
individual protection, 131–136
Joint Service Lightweight Integrated Suit Technology, 111–116, 123–124, 134–136
Joint Service Lightweight Integrated Suit Technology Block 2 Glove Upgrade, 136
Joint Service Personnel/Skin Decontamination System, 137–138
masks, 38, 131–134
patient protective equipment, 146–148
Inhalational anthrax, 60–61
IPE. *See* Individual protective equipment
Irritants. *See* Riot-control agents

J

JB2GU. *See* Joint Service Lightweight Integrated Suit Technology Block 2 Glove Upgrade
JCAD. *See* Joint Chemical Agent Detector
Joint Chemical Agent Detector
cyanide, 29
description of, 142–144
lung-damaging agents, 33
nerve agents, 1
preparation of, 73
toxic industrial chemicals, 33
vesicants, 19
Joint Service General Purpose Masks, 38, 133–134
Joint Service Lightweight Integrated Suit Technology, 111–116, 123–124, 134–136
Joint Service Lightweight Integrated Suit Technology Block 2 Glove Upgrade, 136

Joint Service Personnel/Skin Decontamination System, 137–138
JSGPM. *See* Joint Service General Purpose Masks
JSLIST. *See* Joint Service Lightweight Integrated Suit Technology

K
Korean hemorrhagic fever, 66

L
L. *See* Lewisite
Lacrimators. *See* Riot-control agents
Laryngospasms, 14, 39
Larynx
  description of, 34–35
  inflammation of, 39
Lassa fever, 66
LCt_{50}. *See* Lethal concentration
LD_{50}. *See* Lethal dose
Lethal concentration
  nerve agents, 2
Lethal dose
  nerve agents, 3
Lewisite
  attacks, 87
  military working dogs exposure, 157–162
  overview, 19–20
  physical characteristics of, 20
  signs and symptoms, 19
Litter, decontaminable, 147–148
Litter casualty decontamination, 110–121
Lung-damaging agents. *See also* Respiratory system
  centrally acting, 35–36, 39–40
  clinical effects, 39–41
  decontamination, 33
  detection of, 37
  field care, 41
  field detection, 33
  mechanisms of action, 38–39
  medical management, 33
  military working dogs exposure, 166
  NATO Codes, 33
  overview, 33–34
  peripherally acting, 36–37, 40–41
  physical properties, 38
  protection from, 38
  respiratory system and, 34
  signs and symptoms, 33
  types of, 34–37
Lung sacs
  description of, 34–35
Lungs. *See also* Respiratory system
  vesicants injuries, 27

M
M22 Automatic Chemical Agent Alarm, 1, 19, 73, 144
M90 Chemical Agent Detector, 19, 29
M8 chemical agent detector paper, 1, 19, 73, 86, 99, 105, 139–140
M9 chemical agent detector paper, 1, 19, 73, 86–87, 139
M272 Chemical Water Testing Kit, 19, 29, 144–146
M274 Contamination Sign Kit, 92
M61 filters, 38
M295 Individual decontamination kit, 24, 138
M295 Individual Equipment Decontamination Kit, 24
M45 mask, 131–132
M50 mask, 133–134
M51 mask, 133–134
M53 mask, 134
M21 Remote Sensing Chemical Agent Alarm, 1, 19
M93 series Fox Reconnaissance System, 1, 19, 33
M18A2 Chemical Agent Detector Kit, 1, 19, 29, 33
M256A1 Chemical Agent Detector Kit, 1, 19, 29, 30, 73, 140–141
M4A1 Joint Chemical Agent Detector, 142–144
M40A1 mask, 131–132
M42A2 mask, 131–132
Mafenide acetate, 27
Marburg virus, 66
Masks, 38, 131–134
MCt_{50}. *See* Miosis concentration
MCU-2A/P mask, 132–133
Medical evacuation
  biological agent attack, 60
  vesicants exposure, 25

Medical management
cyanide, 29
incapacitating agents, 49
lung-damaging agents, 33
nerve agents, 1
riot-control agents, 43, 46–47
toxic industrial chemicals, 33
toxins, 67
vesicants, 19
Medical treatment facilities. *See also* Patient decontamination sites
vesicants exposure evacuation, 25
Metals, hazardous
military working dogs exposure, 168
Methylene chloride, 36
Military protective masks, 38
Military working dogs
biological agents exposure, 170–171
chemical, biological, radiological, or nuclear injuries, 149–150
cyanide exposure, 164–165
decontamination, 172–174
incapacitating agents exposure, 162–164
incendiary agents exposure, 167
kennel facility protection, 151
lung-damaging agents exposure, 166
nerve agent exposure, 152–157
nuclear weapons exposure, 172
pretreatment of, 151–152
protection of rations and equipment, 151
protective measures, 150–152
radiological weapons exposure, 172
riot-control agents exposure, 166
smoke exposure, 167
toxic industrial chemicals exposure, 167–170
vesicants exposure, 157–162
Miosis concentration
nerve agents, 1, 2
Mission-oriented protective posture, 10, 23, 59, 74, 92–93, 108–109, 135
Modified table of organization and equipment, 99
MOPP. *See* Mission-oriented protective posture
Mouth
nerve agent effects, 5
MTFs. *See* Medical treatment facilities
MTOE. *See* Modified table of organization and equipment
Multiservice Tactics, Techniques, and Procedures for Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries, 25, 81, 93, 110
Mustard. *See* Sulfur mustard
MWD. *See* Military working dogs

N

Narcotics
as incapacitating agents, 50
Nasopharynx
description of, 34–35
inflammation of, 39
NATO. *See* North Atlantic Treaty Organization
NBC3 CHEM report, 84
NBC1 report, 89–90
Nerve agents
absorption, 152–153
antidotes, 8–15
attacks, 86–87
buddy aid, 8–14
decontamination, 1, 10, 155
drug therapy, 10–15
effects of, 4–9
effects on food and water, 153
field detection, 1
follow-up treatment for severe exposure, 155–157
initial treatment, 155
lethal dose values on skin, 3
mechanism of action, 3–4
medical management, 1
mild symptoms, 13
military working dogs exposure, 152–157
NATO Codes, 1
overview, 1–2
pretreatment, 15–17, 151–152
self-aid, 8–13
severe symptoms, 13–15
signs and symptoms, 1, 153–155
skin exposure, 9
toxicity, 2–3

treatment, 8–15, 155–157
vapor exposure, 8, 13
ventilation, 15
Neurons
nerve agent effect, 3
Neurotransmitters, 3
Nicotine
as incapacitating agent, 50
Nitrogen mustard
military working dogs exposure, 157–162
Nitrogen oxides, 36
North Atlantic Treaty Organization
cyanide codes, 29
incapacitating agent code, 49
lung-damaging agent codes, 33
nerve agent codes, 1
riot-control agent codes, 43
toxic industrial chemical codes, 33
vesicants codes, 19
Nose
nerve agent effects, 5
NOx. *See* Oxides of nitrogen
Nuclear weapons
military working dogs exposure, 172

O

OC. *See* Riot-control agents
Oleoresin capsicum. *See* Riot-control agents
Oropharynx
description of, 34–35
inflammation of, 39
Oxides of nitrogen, 36

P

Palytoxin, 70
Pathogens. *See* Biological agents
Patient decontamination sites. *See also* Decontamination
access of, 96–98
ambulatory casualty decontamination, 121–129
ambulatory patient decontamination line, 100–101, 102
casualty decontamination area, 105
command and control cell, 102
contaminated waste dump area, 106–107
contamination check area, 102
diagram of, 94
disestablishing the site, 107–109
emergency medical treatment area, 102
emergency treatment areas, 100, 104–105
entry control points, 99–100, 102
equipment, 98–101
equipment recovery, 107–109
establishing site, 91–95
hot line patient reception, 103
key planning elements, 82
litter decontamination line, 100–101, 102
monitoring during setup, 92–93
movement control, 96–98
moving casualties through, 80
operations, 103–107
patient flow, 103–107
personnel recovery, 107–109
personnel requirements, 101–103
personnel training, 72
protection during setup, 92–93
rehydration point, 106
rest area, 106
resupply point, 106
security of, 95–96
site closure, 107–109
site preparation phase, 93–95
supplies, 98–101
triage area, 102, 103–104
wind direction and, 91–92
work/rest cycles, 103
Patient protective equipment, 146–148
Patient Protective Wrap Kit, 146–147
PCBs. *See* Polychlorinated biphenyls
PDS. *See* Patient decontamination sites
Pepper spray
as incapacitating agent, 50
Perchloroethylene, 36
Perfluoroisobutylene, 36
Peripheral lung compartment, 34–35, 38–39
PFIB. *See* Perfluoroisobutylene
Phencyclidine
as incapacitating agent, 50

Phenols
military working dogs exposure, 169
Phosgene
attacks, 86
detection of, 37
effects of, 36, 40
field detection, 33
mechanism of action, 38–39
Physostigmine
incapacitating agent antidote, 49, 51
Pinpoint pupils. *See* Miosis concentration
Plague, 62–63
Polychlorinated biphenyls
military working dogs exposure, 168
Post-neuro-syndrome, 7
Potassium iodide, 172
Pralidoxime chloride
nerve agent treatment, 10, 14
Pretreatments
nerve agents and, 15–17
Propylene glycol
military working dogs exposure, 169
Protective equipment. *See* Individual protective equipment
Pseudomembranes, 36
Pulmonary edema, 38–39
Pulmonary system. *See* Respiratory system
Pyridostigmine bromide
nerve agent pretreatment, 15–17, 151–152

Q

Q-fever, 63–64

R

Radiological weapons
military working dogs exposure, 172
RDIC. *See* Resuscitation Device, Individual Chemical
Reactive Skin Decontamination Lotion, 1, 19, 24, 95, 99–101, 105, 111–112, 137–138
Remote Sensing Chemical Agent Alarm, 1
Respiratory system
compartments of, 34–35
nerve agent injuries, 154
toxic industrial chemicals and, 34
vesicants exposure, 27, 159
Respiratory tract
nerve agent effects, 5–6
Response modifiers. *See* Biological agents
Resuscitation
ABCs of, 33
Resuscitation Device, Individual Chemical, 15, 100, 148
Rhinorrhea
nerve agent effect, 1, 5, 13
Ribavirin, 66
Ricin, 69
Rift Valley fever, 66
Riot-control agents. *See also* Incapacitating agents
buddy aid, 46
care provider actions, 46–47
color of, 45
decontamination, 43, 47, 166
detection of, 43, 44
dispensing methods, 45
effects of, 45–46
medical management, 43
military working dogs exposure, 166
NATO Codes, 43
odor of, 45
overview, 44
physical characteristics, 44, 45
self-aid, 46
RSCAAL. *See* Remote Sensing Chemical Agent Alarm
RSDL. *See* Reactive Skin Decontamination Lotion
Rule of nines, 25–26

S

Sarin. *See* Nerve agents
Saxitoxins, 70
SEB. *See* Staphylococcal enterotoxin B

Self-aid
cyanides, 31
incapacitating agents, 51
nerve agents, 8–13
riot-control agents, 46
vesicants, 23–24, 27
Shuffle pits, 128
Silver sulfadiazine burn cream, 27
Skeletal muscle
nerve agent effects, 6–7
Skin
nerve agent effects, 154–155
vesicants exposure, 25–27, 158–159
Smallpox, 64–65
Smoke
military working dogs exposure, 167
SNAPP. *See* Soman nerve agent pyridostigmine pretreatment
Soaps
military working dogs exposure, 169
skin decontamination method, 1, 19, 59
Sodium nitrite, 29
Sodium thiosulfate, 29
Soldier's Manual of Common Tasks, 24
Soman. *See* Nerve agents
Soman nerve agent pyridostigmine pretreatment, 151–152
Spinal cord
nerve agent effect, 7
Staphylococcal enterotoxin B, 69
STB. *See* Super tropical bleach
Steroid antibiotic eye ointment, 25
Sulfur mustard
attacks, 87
detection of, 21–22
effects of, 22–23, 36, 40
mechanism of action, 38
military working dogs exposure, 157–162
overview, 19–20
physical characteristics of, 20
signs and symptoms, 19
Sulfur mustard/lewisite mixture
detection of, 22
effects of, 23
military working dogs exposure, 157–162
overview, 19–20
physical characteristics of, 20
signs and symptoms, 19
Super tropical bleach, 94–95, 107–108
Sweat glands
nerve agent effects, 6
Synaptic clefts, 3
Synaptic receptors, 3–4
Systemic absorption
nerve agents, 154
vesicants, 159–160

T

T-2 toxin, 69
Tabun. *See* Nerve agents
TAP. *See* Toxicological agent protective aprons
Tearing agents. *See* Riot-control agents
Teflon, 36
Tetrodotoxin, 70
TICs. *See* Toxic industrial chemicals
Toxic industrial chemicals
centrally acting, 36–37, 39–40
clinical effects, 39–41
decontamination, 33, 170
detection of, 37
field care, 41
field detection, 33
mechanisms of action, 38–39
medical management, 33
military working dogs exposure, 167–170
NATO Codes, 33
overview, 33–34
peripherally acting, 36–37, 40–41
physical properties, 38
protection from, 38
respiratory system and, 34
signs and symptoms, 33
treatment, 170
types of, 168–170
Toxicity
nerve agents, 2–3
Toxicological agent protective aprons, 101, 105, 118
Toxins
abrin, 70

aflatoxins, 69
botulinum toxins, 68–69
classification of, 67–68
decontamination, 67, 68
detection of, 67, 68
domoic acid, 70
epibatidine, 70
epsilon toxin, 70
mechanisms of action, 67–68
medical management, 67
overview, 67
palytoxin, 70
physical properties, 68
protection from, 68
ricin, 69
saxitoxins, 70
signs and symptoms, 67
staphylococcal enterotoxin B, 69
T-2 toxin, 69
tetrodotoxin, 70
Toxins, biological. *See* Biological agents
Trachea
description of, 34–35
inflammation of, 39
Triage
biological agents, 60
categories, 78–80
definition of, 76
delayed category, 79, 80
expectant category, 79–80
immediate category, 78, 80
minimal category, 79.80
moving casualties through decontamination site, 80
patient decontamination sites, 102, 103–104
vesicants, 25
Tularemia, 65–66
2-PAM CL. *See* Pralidoxime chloride

V

Variola major, 64–65
Venezuelan hemorrhagic fever, 66
Ventilation, assisted
nerve agent treatment, 15
Vesicants
attacks, 86
buddy aid, 23–24
decontamination, 19, 24, 160
detection of, 19, 21–22
effects of, 22–23
field treatment, 24–27
immediate casualty decontamination, 24
medical management, 19
military working dogs exposure, 157–162
mitigation, 21
NATO Codes, 19
overview, 19–20
physical characteristics, 20
self-aid, 23–24
signs and symptoms, 19, 158–160
treatment, 160–162
Vesication, 26–27
VHF. *See* Viral hemorrhagic fevers
Vibrio cholerae, 61–62
Viral hemorrhagic fevers, 66
VX. *See* Nerve agents

W

Water testing kits, 19, 29, 144–146
White phosphorus
military working dogs exposure, 167
Working dogs. *See* Military working dogs

Y

Yellow fever, 66
Yersinia pestis, 62–63

Z

Zinc oxide, 37